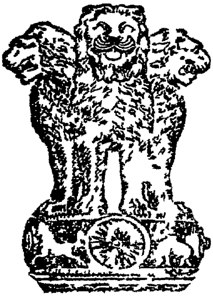

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OF THE DOMINIONS, INDIA AND THE COLONIES

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THE Imperial Institute was founded as the Empire Memorial to the Jubilee of Queen Victoria. The purposes of the Institute, as defined by the Imperial Institute Act of 1925, are as follows :—

1. To promote the commercial, industrial and educational interests of the British Empire.

2. To collect and disseminate :—

(*a*) information relating to possible uses of and markets for new raw materials or semi-manufactured products ;

(*b*) information relating to new uses of and markets for already-known raw materials or semi-manufactured products ;

(*c*) information relating to sources, production, supplies, cost, consumption and requirements of raw materials and semi-manufactured products and legislation relating thereto ;

(*d*) information relating to the best means of increasing supplies or of creating new sources of supplies of such materials and products within the Empire ;

(*e*) information relating to the best means of treating such materials and products and of preparing them for marketing ;

(*f*) technical and scientific information bearing upon the industries of the British Empire.

3. To advise on the development of the resources of the Empire in raw materials in order that such resources may be made available for the purposes of industry and commerce and of Imperial defence.

4. To conduct in the laboratories of the Institute preliminary investigations of raw materials and, when it may be deemed advisable, to arrange for more detailed investigation by appropriate scientific or technical institutions.

5. To collect samples of raw materials having a definite value in industry and commerce.

6. To co-operate with other agencies within the Empire formed for similar purposes.

7. To maintain for public information and instruction in the Exhibition Galleries of the Imperial Institute exhibitions illustrative of the resources and development of the Empire and of its scenery, life and progress and where practicable to organise from time to time temporary exhibitions of a similar nature elsewhere.

8. To do anything incidental to or conducive to carrying into effect all or any of the foregoing purposes.

Under the provisions of the Act aforementioned, the Institute was reorganised and placed under the control of the Department of Overseas Trade. The Parliamentary Secretary of that Department is the responsible Minister and is President of the Board of Governors. This body consists of the High Commissioners of the Dominions and India, representatives of the Colonial Office and certain other Government Departments, and of the Crown Agents for the Colonies, with additional members representing scientific and commercial interests. A list of the Board of Governors will be found on p. 7. The Director of the Institute is Sir Harry A. F. Lindsay, K.C.I.E., C.B.E.

The technical work of the Institute is carried out by two principal Departments, viz., a Plant and Animal Products Department and a Mineral Resources Department. An Advisory Council for each of these groups of products has been appointed, Sir Frank Stockdale, K.C.M.G., C.B.E., being Chairman of the Plant and Animal Products Council, and Sir William Larke, K.B.E., Chairman of the Mineral Resources Council.

A number of Consultative Committees consisting of authorities on the various groups of raw materials co-operate in the work of the Institute, in association with the Advisory Councils, and close touch is maintained with producers, brokers, merchants, and users. Valuable help can thus be given to persons interested in the development of Empire raw materials.

Enquiries.—The Institute maintains a special service for dealing with enquiries relating to the sources, production, uses and marketing of raw materials and for collecting and disseminating general and statistical information on these subjects. This service is available for the use of individuals and firms, as well as of Government Departments.

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Library.—The Library of the Institute contains a large collection of works of reference relating to Empire countries and their products and is regularly supplied with the more important reports and other publications of Government Departments in Great Britain, the Dominions, India, the Colonies and most foreign countries. More than 800 serial publications, mainly of a scientific or technical character, are also regularly received.

The library is available for the use of enquirers between the hours of 10 a.m. and 5 p.m. on week-days (10 a.m. and 1 p.m. on Saturdays).

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Other publications of the Institute include a Descriptive List of Some Empire Timbers; a Report on Grading Rules and Standard Sizes for Empire Hardwoods; Monographs on the Preparation of Empire Hides and Skins and the Tanning Materials of the British Empire; Reports on the Collection of Reptile Skins for Commercial Purposes and the Drying of East African Hides; a comprehensive series of some fifty Monographs covering all the important economic minerals and metals under the title of "The Mineral Industry of the British Empire and Foreign Countries"; an Annual Statistical Summary showing production, imports and exports, British and foreign, of all the metals and minerals dealt with in the Monographs; the Mineral Position of the British Empire; a series of twelve volumes on the Mining Laws of the British Empire; and one dealing with Mining Royalties and Rents in the British Empire. The Institute also issues series of photographic picture postcards relating to Empire subjects. A list of the publications and postcards is obtainable on request.

Public Exhibition Galleries.—Visitors to these Galleries find each country of the overseas Empire represented by a Court of its own in which the home life, scenery and industries are artistically reproduced by means of photographic transparencies, photographs and dioramas. Where possible these exhibits are so arranged on the principle of the "travelogue" that the visitor is taken in imaginative sequence through just those scenes which would have met his eye had he been making the actual trip. Specimens of economic products are also exhibited; and, where possible, the specimens are grouped so as to tell the story of the industry concerned. By this means the lessons taught in text-books of geography or of technical industry are reinforced by the system which has now come to be known as "visual instruction." Lectures and demonstrations in the Galleries are given daily by the Guide Lecturers.

At the Central Stand, which is situated at a central point in the Exhibition Galleries, free literature relating to Empire countries and products is distributed and Imperial Institute publications and picture postcards are on sale.

In the Exhibition Pavilion attached to the Galleries, temporary exhibitions of a commercial or educational character are held from time to time.

The Galleries are open free on week-days from 10 a.m. to 5 p.m., and on Sunday afternoons from 2.30 to 6 p.m.

Cinema.—The Imperial Institute maintains a Cinema Theatre in the Exhibition Galleries. The Cinema is equipped with standard size projectors and screen, and modern lighting, heating and ventilating systems, and has seating accommodation for 370 persons. Films illustrating the life, scenery, and industries in the various countries of the Empire are shown daily at 10.15, 11.35, 2.15, and 3.35 (Sundays 2.45 and 4.15). Special arrangements are made for visits of organised parties from schools and other institutions. Lectures on industries and countries of the Empire are frequently given.

Empire Film Library.—The Empire Film Library was inaugurated at the Imperial Institute by H.R.H. the Duke of Gloucester on Friday, June 14, 1935. It contains a large collection of cinematograph films depicting the industries and agriculture, as well as the life, scenery and products, of the United Kingdom and the Empire overseas. The films are available for loan to schools and other approved institutions in the United Kingdom without charge other than the cost of carriage.

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REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Indian, and Colonial Governments

CLARIFIED BUTTER (GHEE) IN AFRICA

THE method of preparing butter fat free from water, proteins, and salts, in order that it will keep better than ordinary butter, was first developed in India, where the product is known as " ghi " or " ghee." The practice subsequently spread to other warm countries, and in certain of the African colonies an industry in ghee production is being built up which is proving of great help to the native cattle owners. In Tanganyika, for example, the Veterinary Department initiated work on improving methods of preparation which has resulted in a product vastly superior to that made by ordinary native methods and which is being marketed under the name of " clarified butter " to distinguish it from the native ghee. A paper by M. H. French, Biochemist to the Department, describing the methods of making clarified butter fat and also a new process of preparing the material direct from cream, thus dispensing with the churning of butter, was published in this BULLETIN, 1936, **34**, 32. The information contained in this article, together with additional technical details, was later issued by the Veterinary Department as Bulletin No. 2 of an Animal Husbandry Series, by M. H. French and M. J. Lowe. The Imperial Institute has assisted the Department with advice in various directions, and by examining and reporting on the quality of samples of their products.

According to the Annual Report of the Department of Veterinary Science and Animal Husbandry, Tanganyika, 1936, there were in that year ten factories producing certified clarified butter in the Central Province, with an output of 30·4 tons. In the Western Province there were three factories, with an output of 4·2 tons. The production of this certified clarified butter is still under direct departmental supervision, but in Musoma (Lake Province) there is a flourishing ghee industry which is entirely privately managed, although the assistant livestock officer in the district gives much help and practical advice. The quality of the Musoma ghee is good, though, of course, below the uniformly high standard demanded of the factory certified product, and no difficulty was experienced throughout 1936 in disposing of it. The total production in Musoma that year was about 700 tons, valued at £37,450. It is in great demand, not only within the Territory, but also for export to neighbouring countries. Through the exertions of the Department up-to-date separators and churns are now in common use by the natives.

In Nigeria, also, an important butter fat industry is being built up among the native cattle owners of the Northern Provinces. The production of ghee for local use had long been carried out in that region, and in 1932 the Veterinary Department decided to explore the possibilities of establishing an export trade in the material. In the following year one of the Veterinary Officers, Mr. L. H. Saunders, visited this country and investigated the market conditions. The whole question was discussed with him at the Imperial Institute, and assistance rendered in connection with the packing of the product, methods of examination, and so forth. Samples of clarified butter fat, prepared experimentally in Nigeria, were also examined and reported on. A trade in the product sprang up, and after a year or two the business was taken over from the Department by the United Africa Company, Ltd. Butter-buying centres have been opened up by the firm at suitable places in the Northern Provinces, and the butter is sent to up-to-date factories which have been erected at Kano and Jos respectively, where the clarified butter fat is prepared for export. The product is of splendid quality and commands a ready sale in the United Kingdom. According to the Annual Report of the Veterinary Department, 1936, 547 tons, valued at £18,993, were exported that year, as compared with 321 tons, valued at £11,821, in 1935. It is estimated that with the trade properly organised the export of butter fat should before long reach 1,000 tons annually.

Amongst other African countries which are endeavouring to build up an industry in clarified butter are Nyasaland, the Gambia, and the Anglo-Egyptian Sudan. Samples of the product prepared experimentally in the two last-named countries have been received recently at the Imperial Institute, and the results of their examination are given below.

I. Samples from The Gambia

This sample, received in August 1936, was stated to represent clarified butter fat produced by a method not previously employed in West Africa. Mr. L. H. Saunders, who, as already mentioned, had been concerned in the early development of the Nigerian ghee industry, on appointment to the Agricultural Department, Gambia, made a survey of the livestock by-products in the latter colony. He found that the Fula cattle owners were employing a process of making a "cooked" butter from cream, without churning, and devised a method which combined this process with that he had introduced into Nigeria. The following outline of the process for use on a commercial scale has been supplied by Mr. Saunders: Cream is to be collected from the Fula cattle owners and ripened at the manufacturing depot. The cream must be in as fresh a state as possible, neither over-acid nor rancid. When ripened, the cream is put into a container furnished with a water jacket and slowly heated to a temperature of about 80° C. When the curd precipitates, the fat is filtered through a filter with a cotton wool disc. The filtered fat is then placed in a second container, heated to 65° C., and kept at this temperature for about 20 to 30 minutes to evaporate the moisture. The fat is then refiltered into sterilised containers, and after being allowed to cool, is sealed for storage.

The sample of clarified butter fat (ghee) as received at the Imperial Institute consisted of a pale yellow, soft fat, with a somewhat rancid odour. When melted the fat was slightly cloudy and of golden-yellow colour. A small amount of water separated out, and a trace of curd was present.

The ghee was examined with the following results, which are shown in comparison with the ranges of corresponding figures obtained for three samples of ghee from Nigeria previously examined at the Imperial Institute :—

	Present Sample.	Samples from Nigeria.
Moisture . . . . *per cent.*	0·6	0·2—0·7
Expressed on the moisture-free filtered fat :		
Specific gravity at 100°/15·5° C. .	0·8638	*0·8638 and 0·8649
Melting point (by open tube method)	32·3° C.	*34·0° and 35·7° C.
Refractive index at 40° C. . .	1·4532	1·4535—1·4540
Acid value	2·6	*4·2 and 5·3
Saponification value	231·3	224·7—228·3
Iodine value (Wijs, 1 hr.) *per cent.*	28·9	*30·1 and 33·2
Reichert-Meissl value	31·35	26·35—29·1
Polenske value	2·5	2·0—2·25
Kirschner value	23·08	20·8—21·87
Baryta values :		
Total (a) .	313·8	307·1—312·0
Insoluble (b) .	251·2	252·8—254·0
Soluble (c) .	62·6	54·2—58·4
b—(200+c) .	—11·4	—0·2 to —4·8

* *In the case of these constants only two samples are concerned.*

These results show that the moisture content of the present sample is higher than is desirable, as in order to ensure that ghee will keep in a sound condition the amount of moisture should be below 0·2 per cent. The constants of the moisture-free fat indicate, however, that the ghee is of normal composition, and are similar to those obtained for the samples from Nigeria previously examined at the Imperial Institute. The slight differences that exist are not significant, being merely such as might be expected from butter fats produced in different countries.

The ghee, together with particulars as to the mode of preparation employed, was submitted to Messrs. Lever Bros., Ltd., who through their associated company, the United Africa Company, Ltd., are already handling ghee from Nigeria. They reported as follows :—

" The United Africa Company would anticipate no difficulty in dealing also with ghee from the Gambia, provided that the price and the quality are satisfactory. The analytical data on the present sample show that it is very good average sample of West African ghee, but we find it necessary to exercise caution, in that, apparently, the quality varies considerably according to season. This applies especially to such important factors as the Reichert-Meissl value, which is highest when the cattle obtain the young pasture at the beginning of the rains, and from then tends to fall away as the dry season approaches and the grass becomes harder and less nutritious.

"The moisture content is a matter of some importance for the proper keeping of ghee intended for the export market, and if the method of preparation is carried out properly there should be no difficulty in keeping the moisture content down to figures between 0·1 and 0·2 per cent."

Conclusions

The present sample of ghee from the Gambia is of promising quality, and consignments of similar ghee, if offered with a moisture content below 0·2 per cent. and free from rancidity, should find a ready market in the United Kingdom.

II. SAMPLE FROM THE ANGLO-EGYPTIAN SUDAN

The sample, which is the subject of this report, was forwarded to the Imperial Institute by the Director, Sudan Veterinary Service, in September 1937. It was stated to have been prepared direct from cream by the method recommended by Mr. M. H. French (see p. 13).

The sample consisted of clarified butter fat in good, clean condition and free from rancid odour. A slight amount of curd was present.

The sample was examined with the following results, which are shown in comparison with the ranges of corresponding figures obtained for samples of ghee produced in other parts of the British Empire and previously examined at the Imperial Institute :—

	Present Sample.	Samples from other parts of the British Empire.
Moisture *per cent.*	0·16	0·2—0·9
Expressed on the moisture-free filtered fat :		
Specific gravity at 100° C./15.5° C.	0·8645	0·8638—0·8655
Melting point (by open tube method)	32° C.	32·3—35·7° C.
Refractive index at 40° C	1·4537	1·4530—1·4555
Acid value	1·0	0·5—7·5
Saponification value	229·5	224·7—231·3
Iodine value (Wijs, 1 hr) *per cent.*	32·0	27·8—33·2
Reichert-Meissl value	27·7	26·35—31·35
Polenske value	2·4	2·0—2·8
Kirschner value	20·3	20·2—23·08
Baryta values :		
Total (a)	313·7	307·1—316·2
Insoluble (b)	253·6	248—256·2
Soluble (c)	60·1	54·2—62·6
b—(200+c)	—6·5	—0·2 to —13

The results of the examination show that the moisture content and the acidity are satisfactory. The analytical figures of the moisture-free fat indicate that the ghee is of normal composition for butter fat. These results are similar to those obtained for samples of ghee from other countries of the British Empire, previously examined at the Imperial Institute ; the slight differences that exist are such as might be expected from butter fats produced in different countries.

There is a good demand for ghee in this country, present prices, c.i.f. London, being from about £65 to £75 per ton or even higher, according to quality (December 1937). Quotations have varied in the last few years from as low as £50 to as high as £80 per ton, but the bulk of the business has been done at prices ranging from £60 to £75 per ton. Prices tend to fluctuate with those of New Zealand and Australian butter, since ghee, though not recognised in England as an " edible " fat in the ordinary sense, nevertheless competes with other fats for cooking purposes.

An important use of ghee in this country is for ships' stores. In order to comply with the Board of Trade regulations governing products supplied for food purposes to ships it must not contain more than 2½ per cent. of free fatty acids (equivalent to an acid value of 5). If the material as imported contains a higher percentage than this, it has to be neutralised before it can be used, and, in addition, there are sometimes impurities (dirt) to be removed. It is, therefore, important, in order to obtain the best prices, that the material shipped should be both clean and as nearly neutral as possible. The moisture content should be kept below 0·2 per cent. in order to ensure that the ghee will keep in sound condition.

Ghee similar to the present sample would be readily saleable in this country and should be worth about £75 per ton (December 1937).

COMPARATIVE VALUES OF NEWFOUNDLAND SPRUCE AND FIR AND RUSSIAN SPRUCE AS SOURCES OF PAPER PULP

An investigation was carried out at the Imperial Institute during 1937, at the request of the Department of Natural Resources, Newfoundland, in order to ascertain the comparative paper-making properties of two woods produced in that Dominion and a Russian wood. The Newfoundland woods were understood to be the black spruce and the balsam fir; the "Russian wood" was presumed to be spruce. The material supplied consisted of 29 logs free from bark. Six of the logs were of Russian wood, each 7 ft. in length; the logs of Newfoundland spruce and fir were 3 ft. in length. The report on the results of the investigation is given in the following pages and is divided into four parts, dealing respectively with the resin content of the timbers, their densities, and pulping trials with the soda and the sulphite processes. The cellulose content of the woods and the fibre dimensions are dealt with in the last section (p. 23).

I. THE RESIN CONTENT OF THE TIMBERS

A representative portion of the chips prepared from each sample for the paper-making experiments was ground in a disintegrator. In chipping the Newfoundland fir a number of small hard knots were encountered, and these were examined separately for resin content. The knots removed in this way constituted about 5·9 per cent. by weight of the portion examined.

In estimating the resin content of these woods the amounts of resinous material (including oils and waxes) extracted by ether, and also by a mixture of alcohol 33 per cent. and benzene 67 per cent. by volume, were determined. The results are given below and are expressed in each case on the moisture-free or "oven-dry" wood :—

	Moisture.	Resins, etc., removed by ether.	Resins, etc., removed by alcohol-benzene.
	Per cent.	*Per cent.*	*Per cent.*
Newfoundland spruce	5·4	0·9	2·0
Newfoundland fir—			
Complete material	5·9	1·3	3·4
Wood deprived of knots	6·0	1·0	3·0
Knots only	5·6	5·1	9·2
Russian wood	7·2	1·4	2·5

It will be seen from these results that there is no very great difference in the resin content of these samples of wood as indicated by the amount extracted by ether. The Newfoundland fir, however, furnished rather more resinous material soluble in alcohol-benzene than either of the spruces. This was largely due to the presence in the fir of knots which in comparison with the wood deprived of knots contained a high percentage of resinous material. In commercial practice these knots would be largely removed in the screening of the chips.

Recorded figures for the resin content of American and Canadian spruces used for pulp manufacture, as shown by the amount extracted from the wood by ether, vary considerably according to the species (black or white spruce) and the condition of the wood (seasoned or green); values of from 0·24 to 1·8 per cent. are reported. The amount of resinous material removed from the wood by other solvents and by mixtures of solvents such as alcohol-benzene, and ether-alcohol, are likewise subject to considerable variation, and the figures which have been published range from 0·6 to 3·3 per cent.

Figures recorded by different observers for the amount of resinous material removed from American balsam fir by the same solvents also vary a good deal. The figures given are from 0·45 to 1·2 per cent. for ether extract and 1·4 to 2·5 per cent. for material extracted by means of ether-alcohol. It will be seen that these figures are rather below those obtained for the present sample of Newfoundland fir.

II. Densities of the Timber

Sections varying in thickness from 1 to 2½ in. were cut from three logs each of the Newfoundland fir, Newfoundland spruce, and Russian wood, the sections being cut so as to be representative of the smaller, intermediate, and larger logs of each species of wood. The cross-sectional area of each section was accurately measured by means of a planimeter and the thickness determined by means of a pair of vernier callipers, and from these two measurements the volume of the section was calculated.

The following table gives the cross-sectional area, moisture content and density of each section:—

	Cross-sectional area.	Moisture.	Density in lb. per cubic ft. Air-dry weight expressed on air-dry volume.	Density in lb. per cubic ft. Oven-dry weight expressed on air-dry volume.
Newfoundland fir	*sq. in.*	*Per cent.*		
Smaller logs . .	25·04	9·8	25·8	23·3
Intermediate logs .	28·07	10·6	25·8	23·1
Larger logs . .	36·42	10·2	22·9	20·6
Newfoundland spruce				
Smaller logs . .	14·39	10·6	39·9	35·7
Intermediate logs .	24·30	10·9	34·5	30·7
Larger logs . .	45·01	11·1	32·9	29·2
Russian wood				
Smaller logs . .	42·07	10·8	30·2	26·9
Intermediate logs .	49·00	9·8	30·2	27·2
Larger logs . .	55·95	11·0	32·0	28·5

It will be seen from the foregoing table that the Newfoundland spruce and the Russian wood possessed considerably greater density than the Newfoundland fir, and that of the two first-named woods the Newfoundland spruce was the more dense.

The logs of the Russian wood were more uniform in density than those of the other woods, but it must be borne in mind that fewer Russian logs were received and that these were of more even size.

The lower density of the fir is a definite disadvantage, as this wood would thus show a lower weight per cord, and the weight of chips taken by a digester of a given capacity would be reduced accordingly.

III. Pulping Trials by the Soda Process

Representative portions of the three species of wood were cut into chips of about $\frac{3}{4} \times \frac{1}{4} \times \frac{1}{4}$ in., and the chips digested with caustic soda under conditions approximating to those employed commercially for the production of pulp by the soda process. The conditions employed and the yields obtained are given in the following table :—

	Series A.			Series B.		
Parts of caustic soda used per 100 parts of :						
Chips	20			24		
Solution	4			4		
Conditions of digestion :						
Time *hours*	6			7		
Temperature °C.	160			160		
	Newfoundland		Russian	Newfoundland		Russian
	Fir.	Spruce.	Wood.	Fir.	Spruce.	Wood.
Moisture content of chips, *per cent.*	10·6	11·1	13·6	10·6	11·1	13·6
Parts of caustic soda consumed per 100 parts of chips	12·2	12·1	11·9	12·7	13·5	12·7
Yield of moisture-free pulp :						
Calculated on original chips :						
Unbleached *per cent.*	47·2	45·2	42·4	42·8	43·4	39·7
Bleached *per cent.*	46·8	43·3	39·8	38·0	38·5	36·4
Calculated on moisture-free chips :						
Unbleached *per cent.*	52·8	51·2	49·1	47·9	48·8	45·9
Bleached *per cent.*	52·3	48·7	46·1	42·5	43·3	42·1

Under the conditions employed for the trials of Series A, the three woods behaved similarly. They all gave pulps which were not quite fully cooked and did not respond to the bleaching treatment.

The conditions for the second series (B) of boils were consequently made slightly more drastic, by increasing the time of digestion and augmenting the quantity of alkali present. Under these conditions the woods all gave well-cooked pulps, which, however, did not bleach fully so that good white papers were not obtained. In order to make white papers, digestion under somewhat more severe conditions would therefore be necessary.

The yields of pulp obtained in Series A are not very significant as the pulps were not fully cooked. In Series B the yields of unbleached pulp on the air-dry chips were 42·8 per cent. for the Newfoundland fir, 43·4 per cent. for the Newfoundland spruce, and 39·7 per cent. for the Russian wood, but as the last-named wood was received in an appreciably moister condition than the two other woods a better comparison can be made between the corresponding yields calculated on the oven-dry wood, which are seen to be 47·9, 48·8, and 45·9 per cent. respectively. It will be observed that on this basis the two Newfoundland woods gave very similar yields of unbleached pulp and that both yields were slightly above that obtained from the Russian wood.

For the bleached pulps the yields from moisture-free chips are seen to be 42·5, 43·3, and 42·1 per cent. for the Newfoundland fir, Newfoundland spruce, and Russian wood, respectively. These figures do not differ materially, but such superiority as there is again rests with the Newfoundland woods.

Hand-made sheets of paper were prepared from the unscreened pulps, both bleached and unbleached. The three woods all gave strong sheets of similar appearance. In Series B the Newfoundland spruce gave the bleached paper of most satisfactory colour, but the difference in colour between the three bleached papers was very small.

Conclusions

(1) When pulped by the soda process, the Newfoundland fir and Newfoundland spruce gave similar yields of unbleached and bleached pulp which were slightly higher than that obtained from the Russian wood.

(2) For the manufacture of soda pulp the Newfoundland fir

and Newfoundland spruce do not seem to require different treatment and could accordingly be used together.

IV. Pulping Trials by the Sulphite Process

The ground-up materials, as prepared for the estimation of their resin content (see p. 19), were chemically examined with the following results:—

	Newfoundland Fir	Newfoundland Spruce	Russian Wood.
	Per cent.	*Per cent*	*Per cent.*
Moisture	6·0	5·4	7·2
Ash	0·5	0·5	0·4
Cellulose, expressed on original wood	54·3	53·6	53·7
Cellulose, expressed on moisture-free wood	57·8	56·7	57·9

The dimensions of the ultimate fibres of the woods were determined, and the results are shown in the following table:—

	Newfoundland Fir		Newfoundland Spruce		Russian Wood.	
	Length	Breadth	Length.	Breadth.	Length	Breadth.
	mm.	*mm*	*mm.*	*mm*	*mm.*	*mm.*
Maximum	4·51	0·078	4·84	0·056	4·12	0·078
Minimum	1·22	0·022	1·10	0·022	0·96	0·022
Average	2·72	0·046	2·84	0·037	2·64	0·046
Ratio, average length/average breadth	59 : 1		77 : 1		57 : 1	

These measurements show that both the Newfoundland woods are of excellent fibre length from a paper-making standpoint, and that there is no material difference in this respect between them and the Russian wood.

Experimental sulphite digestions were carried out in a stainless steel digester of about 4 litres capacity. The digester was heated directly, but a lead false bottom was fitted to prevent any local over-heating of the chips. The digester was not equipped to allow of the "blowing" of the chips at the end of the digestion, but by hosing the digester with cold water it was found possible to open up within 10 to 15 minutes of the completion of the digestion period.

The experimental procedure was as follows: A quantity of 300 gms. of air-dry, hand-sorted chips was charged into the digester together with 3,000 c.c. of sulphite liquor, which had been prepared by passing sulphur dioxide into an aqueous suspension of calcium and magnesium carbonates (present in amounts equivalent to 0·7 per cent. CaO and 0·3 per cent. MgO respectively), until, on analysis, the liquor contained 5 per cent. free SO_2 and 1·2 per cent. combined SO_2, making a total of 6·2 per cent. SO_2. After charging, the digester was closed and the chips allowed to soak overnight. During the actual digestion of the chips, temperature and pressure readings were taken every 15 minutes (every 7½ minutes during the first hour or two) and plotted. The pressure was controlled by allowing sulphur dioxide to escape from a relief valve.

After a number of preliminary trials it was found that satisfactory pulps could be obtained under conditions such that a maximum pressure of 65 lb. per sq. in. was reached in 2 hours and a maximum temperature of 140° C. in 7 hours; the total time of digestion occupied 10 hours.

Each of the three timbers, and a mixture consisting of 50 per cent. of the Newfoundland spruce and 50 per cent. of the Newfoundland fir, was then digested under the foregoing conditions, with sulphite liquor in the amount and of the strength already stated. At the completion of each digestion the digester was rapidly cooled until it could be opened and the contents washed out. The cooked chips were at once thoroughly washed, being kneaded during this operation in order to separate the fibres. The washed pulp was then transferred to the breaker, broken, again washed, and the yield of moisture-free pulp determined.

This unbleached pulp was divided into two portions. From one portion hand-made sheets of unbleached paper were prepared; the other portion was bleached with standard bleaching powder solution containing 35 per cent. of available chlorine (10 per cent. calculated on the original chips). The resulting bleached pulp was washed and, after the yield had been determined, used to prepare sheets of hand-made paper.

The amounts of moisture in the chips, and the yields of bleached and unbleached pulp obtained from the three materials are set out in the following table:—

	Newfoundland Fir.	Newfoundland Spruce.	Russian Wood.	Mixture of 50 per cent. Fir and 50 per cent. Newfoundland Spruce.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	12·1	11·2	11·1	11·7
Yield of moisture-free pulp:				
Calculated on air-dry chips:				
Unbleached .	44·8	46·7	47·7	43·9
Bleached . .	40·5	43·3	43·8	41·8
Calculated on moisture-free chips:				
Unbleached .	51·0	52·6	53·7	49·7
Bleached . .	46·1	48·8	49·3	47·3

These results show that all three woods furnished satisfactory amounts of sulphite pulp, though the yield from the Newfoundland fir was a little lower than that from the two spruces. The conditions of digestion employed gave pulps which bleached fairly easily, although the pulp from the Russian wood behaved rather differently from the others.

Hand-made papers were prepared from unscreened stock of the various pulps. The papers so obtained were all long-fibred, tough, and strong. That produced from the mixture of Newfoundland fir and Newfoundland spruce would very probably show certain differences in quality from that produced from the spruce alone, but these differences are not sufficiently marked to be evident in hand-made sheets.

Conclusions

It must be pointed out that the present investigation is by no means exhaustive. A complete test of the value of the Newfoundland spruce and fir as raw materials for the production of sulphite pulp would involve carrying out a series of cooking trials on each of the woods, both separately and mixed in various proportions and exploring the effect of altering, within the limits employed in practice, all the many variables of the process, such as the ratio of acid liquor to wood, concentration of combined and of free sulphur dioxide, the time of digestion, rate of heating, maximum temperature, maximum pressure, etc. Such a complete investigation was beyond the scope of the present report.

The results recorded strictly refer to one set of conditions only, which were made to correspond as closely as possible, subject to the limitations of available laboratory plant, to those likely to be used in large-scale practice.

With the above reservation it is concluded from the results of the investigation that good quality sulphite pulps can be made both from the Newfoundland spruce and the Newfoundland fir. Further, since no major differences in the behaviour of the two woods on sulphite digestion were detected, and a mixture of the two in equal proportions pulped satisfactorily, the results afforded no evidence that the two materials need be cooked separately.

ALDER WOOD AS A PAPER-MAKING MATERIAL

The Imperial Institute recently had occasion to investigate the paper-making possibilities of alder wood grown in Wales. As very little information appears to be on record regarding the use of the wood for this purpose the results of the examination of the material are now published.

Two logs of the wood were received: one, which still had the bark adhering, weighed 22½ lb., was 3 ft. 8 in. in length and approximately 8 in. in diameter, and the second, from which the bark had been removed, weighed 13 lb., was 6 ft. 4 in. in length and 4½ in. in diameter, tapering to 2½ in.

The unbarked log was in a very wet condition and was cut up after the removal of the bark and air-dried before examination.

A representative portion of the air-dried wood was finely ground and chemically examined with the following results:—

	Expressed on the air-dry material. *Per cent.*	Expressed on the moisture-free material. *Per cent.*
Moisture	12·2	—
Ash	0·30	0·34
Resins (extracted with alcohol benzene) . . .	3·0	3·4
Cellulose (by chlorination) .	54·9	62·5

The dimensions of the ultimate fibres obtained from the wood were measured by means of a projection microscope. The figures given in the following table represent the results of 100-length and 100-breadth determinations:—

	Length. *mm.*	Breadth. *mm.*
Maximum . . .	1·30	0·043
Minimum . . .	0·45	0·011
Average . . .	0·85	0·024
Mostly . . .	0·65 to 1·10	0·02 to 0·03

The ratio, average length/average breadth was 35 : 1.

The microscopic appearance of the ultimate fibres exhibited the normal characteristics of deciduous wood fibres. The shortness of the fibres was a noticeable feature.

Paper-Making Trials.—A short-fibred deciduous wood such as the present sample would, if capable of an outlet in pulp manufacture, be most suitable for conversion into soda pulp. The investigation of the paper-making value of the material was accordingly carried out by the soda process.

After first removing the bark from the unbarked log, sections exactly ¾ in. in width were sawn from the two logs at intervals along their length. These sections were reduced to chips which were thus of uniform length. The chips were hand-sorted to remove small fragments and excessively large pieces. A fairly uniform product was obtained and the moisture content of the chips was determined.

During the cutting of the wood it was noticeable that a freshly exposed surface, although initially white, very soon acquired a bright yellow or orange-red colour.

The digestion of the chips was carried out in a rotary digester under conditions approximating to those employed commercially for the production of wood pulp by the soda process. The conditions employed and the yields obtained are set out in the following table :—

	Trial A.	Trial B.	Trial C.	Trial D.	Trial E.	Trial F.
Parts of caustic soda used per 100 parts of :						
Air-dry chips . .	20	16	20	20	24	28
Solution . . .	4	4	4	4	4	4
Conditions of digestion :						
Time . . . *hours*	5	4	4	7	5	6
Temperature . °C.	160	160	160	160	160	160
Parts of caustic soda consumed per 100 parts of :						
Air-dry chips . .	14·0	—	13·3	14·1	14·7	15·4
Caustic soda in solution at end of boil *per cent.*	1·20	—	1·34	1·18	1·55	1·80
Yield of moisture-free pulp :						
Calculated on air-dry chips :						
Unbleached . *per cent.*	43·7	*	44·1	43·3	42·5	40·6
Bleached . *per cent.*	41·7	*	43·0	41·6	39·4	38·8
Calculated on moisture-free wood :						
Unbleached . *per cent.*	49·9	*	50·3	49·4	47·9	46·2
Bleached . *per cent.*	47·6	*	49·0	47·5	44·9	44·2

* *Not fully cooked. Yield not determined.*

The moisture content of the air-dry chips was 12·2 per cent.

Unbleached Paper.—The chips were first digested under the conditions of Trial A and a well-cooked pulp resulted. It was next necessary to ascertain whether under slightly less drastic, and therefore more economical conditions of digestion, a satisfactory pulp could be obtained in greater yield. Two further digestions, B and C, were accordingly carried out in order to investigate this point. Trial B, in which both the amount of caustic soda used and the cooking time were less than in Trial A, did not yield a fully cooked pulp. Trial C, however, in which only the time was reduced from 5 hours to 4 hours and all other variables were the same as in Trial A, gave a pulp which was just sufficiently cooked. The yield of unbleached pulp was, moreover, slightly higher than was obtained under the conditions of Trial A.

This yield of unbleached pulp obtained in Trial C, viz., 50·3 per cent., may be taken, since milder conditions do not produce a fully cooked pulp, as closely approximating to the maximum yield of unbleached pulp obtainable from the material. In practice, processes would not be carried out with laboratory precision and a slightly lower yield would be expected. The difference, however, should not be material, and it is clear from these results that under optimum conditions a good yield of unbleached pulp could be produced.

Sheets of hand-made, water-leaf paper were made from the unscreened pulps obtained in Trials A and C. The papers showed the pulp to have been evenly cooked and free from shive. They were light brown in colour, fairly soft, and of fairly good strength for a short-fibred paper. Pulp such as that from which this paper was made would be capable of use as a filler for wrappings, or possibly, in view of the fairly good strength of the papers, the pulp might be used alone in the manufacture of wrappings of a quality for which high strength is not demanded.

Bleached Papers.—The pulps from Trials A and C were bleached with bleaching powder solution using 12½ per cent. of standard bleach on the weight of air-dry chips taken. This corresponds to more than 28 per cent. of standard bleach on the moisture-free unbleached pulp. Neither pulp, however, gave a white paper even with this excessive quantity of bleach. It was evident, therefore, that although the cooking conditions were sufficiently drastic to break down the chips into ultimate fibres, the action of the digestion had not been severe enough to free the fibres from ligneous incrustants and the bleach demands of the pulps were consequently uneconomically large. Further trials were accordingly undertaken, employing more drastic cooking conditions.

In Trial D the time of digestion was extended to 7 hours while other conditions remained unchanged. The resulting yields of unbleached and bleached pulp were only slightly below those recorded for the previous digestions and a white paper was not produced on bleaching. From consideration of the soda consumption figures and the calculated concentration of the residual alkali at the end of the digestion, it became clear that a further increase in the time of digestion would not effect any material purification of the fibre, and that more alkali must be used to produce the necessary delignification. Digestion under the conditions of Trial E, in which the amount of alkali present was increased to 24 parts per 100 parts of air-dry chips, yielded a pulp which bleached with 10 per cent. of standard bleach on the air-dry chips (i.e. 23·5 per cent. standard bleach on the moisture-free, unbleached pulp) to a satisfactory white colour. A final digestion (Trial F) was carried out using 28 parts of caustic soda to 100 parts of air-dry chips and boiling for 6 hours. These conditions still further reduced the bleach demand of the pulp, a satisfactory white paper being obtained with the use of 7½ per cent. of standard bleach on the air-dry chips, corresponding to 18·5 per cent. of standard bleach on the moisture-free unbleached pulp. The yield of bleached pulp obtained in Trial E was 44·9 per cent. and in Trial F 44·2 per cent., each on the moisture-free basis.

The above results demonstrate that by boiling under appropriate conditions Welsh alder wood will give a satisfactory yield of a pulp which will bleach to a good white colour. The precise conditions used in practice would need to be worked out in the mill with reference to the relative costs of digestion and of bleaching and the yield of pulp obtained. It is probable that commercially the tendency would be to boil so as to reduce the bleach demand of the pulp below that of the pulp of Trial F. This would most likely be achieved by cooking at a slightly higher temperature (and therefore pressure) or by lengthening the digestion time, or by altering both variables at the same time.

Hand-made, bleached water-leaf papers prepared from the pulp were found to be of a satisfactory whiteness for soda pulps and were of fairly good strength, but they were decidedly harsher than esparto paper. Pulp such as that from which the papers had been prepared would be suitable for use in the manufacture of printing and writing papers in the same way as the soda pulps prepared from deciduous woods already commercially available. It must be pointed out, however, that comparatively little soda wood pulp is used in this country, as paper-makers in the United Kingdom prefer to employ esparto for the purposes for which paper-makers abroad utilise soda wood pulp.

Conclusions

(1) The present investigation has shown that Welsh alder wood will give, by the soda process, an unbleached pulp suitable for use in the manufacture of wrapping papers either alone or, where greater strength is required, in admixture with stronger pulps.

(2) Welsh alder wood can be cooked to give a pulp which will bleach to a satisfactory whiteness and which would be suitable for the uses for which bleached soda pulps are normally employed. The alder wood pulp, in comparison with commercially available soda pulps, would have the disadvantage of being of shorter fibre length. The yield of bleached pulp obtained from the wood would be somewhat below 44 per cent. (moisture-free basis) depending on the extent to which the pulp was boiled to give an " easy-bleaching " pulp.

(3) Despite the above conclusions, questions of cost and supply render it unlikely, in normal circumstances, that Welsh alder wood could find an outlet as a paper-making material. The wood is only suitable for the manufacture of soda pulp and no wood soda pulp is at present being manufactured in this country, so that a mill for the specific purpose of dealing with the timber would be required. The erection of such a unit would only be justified if sufficiently large quantities of timber were available and reafforestation were practised to ensure continuity of supply. Furthermore, the pulp produced would have to compete with esparto which British paper-makers prefer to even the best grades of soda wood pulp.

ARTICLES

PYRETHRUM IN KENYA

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The development of the pyrethrum industry in Kenya is a very fine example of close collaboration between the farming community and the officers of the Department of Agriculture. At every stage of the development has this collaboration existed, and probably due to it is the rapid increase. The industry as such can be said to be only five years old, yet Kenya pyrethrum is well established on the market, and enjoys a well-deserved reputation.

History

When the great value of pyrethrum as an insecticide became recognised, it appeared to the writer that here was a crop suitable to the Kenya Highlands. In view of the uncertainty of the seed supply an unsuccessful attempt was made in 1927 to obtain a small quantity of " pedigree " seed from the experimental plots of the Plant Pathological Laboratory of the Ministry of Agriculture at Harpenden. However, in 1929, Mr. Anderson, the Senior Entomologist, as a personal favour, was able to secure a little of this pedigree seed. This was sown in nurseries at the Scott Agricultural Laboratories immediately on arrival, and the seedlings were planted out early in November of that year. The first flowers appeared in August 1930, from which a representative sample was collected and analysed. The Pyrethrin I content, 0·5 per cent., was sufficiently encouraging to warrant further trials. In addition, the yield per acre, although many of the plants did not flower, was about 6 cwts., much of which was seed.

In order to ascertain the conditions most suited to it, small quantities of seed were distributed to as many farmers as possible, a procedure accelerated in 1931, when the Departmental Plant Introduction Service was instituted, partly with seed of our own production and partly with a further consignment of several pounds more seed from Harpenden.

Meanwhile, in 1928, Captain Gilbert Walker, of Nakuru, who is continuously experimenting with possible new crops—a most valuable member of a new community—successfully established pyrethrum from Dalmatian seed, and was producing both flowers and seed when the demand for both arose. He is certainly the first grower of pyrethrum in Kenya. Not only this, but his interest in the development of the industry in all its aspects has assisted the industry enormously, and merits the gratitude of the increasing numbers of pyrethrum growers.

By 1932 we learned that pyrethrum would flower, under the conditions of the Kenya Highlands, from altitudes of 5,500 ft. upwards. Below 5,500 ft. a very few plants might flower, but generally there were none. Luckily the Scott Agricultural Laboratories are just above this limit. Here, at the first introduction, only about 40 per cent. of the plants flowered. With increasing altitude the percentage of non-flowering plants decreases until at about 8,500 ft. it approaches zero. Incidentally, continuous selection has given us a strain of which at the Scott Agricultural Laboratories nearly 80 per cent. flower in their first year. The yield at the lower elevations also is poor, but as one rises so it increases.

With this information at our disposal it was possible to institute a " drive " to encourage pyrethrum growing, and here Captain Gilbert Walker's early planting was of the greatest value, as he was in a position to supply acclimatised seed. Partly as a result of this drive and partly as a result of the use by coffee planters of a pyrethrum-kerosene extract for combating Capsid and Antestia [1], a number of people began serious planting of pyrethrum.

In 1933 the Kenya Pyrethrum Growers' Association was formed. The functions of this purely unofficial body were to encourage and promote the growing and marketing of pyrethrum. Under the auspices of the Association the local demand for pyrethrum was met and export was started. During this period the high quality of Kenya pyrethrum became known, samples analysed both in Great Britain and in America had total pyrethrin contents of over 1·40 per cent. In view of this high content the importation of pyrethrum seed was prohibited, lest inferior strains were introduced. Most of the Kenya pyrethrum is derived from the strain introduced by Captain Gilbert Walker and the Harpenden strain; one or two minor importations were, however, made in 1932 and 1933, prior to the prohibition.

At the request of the industry an Ordinance was passed in August 1935 to regulate the sale of pyrethrum. Under the Ordinance the regulation of the industry is vested in the Pyrethrum Board, a body elected by the pyrethrum growers. At the Annual General Meeting of the Pyrethrum Growers' Association in 1936, the Board was formally elected and the Association dissolved. The establishment of a statutory body to control the industry, and the compulsory registration of all pyrethrum growers, with the establishment of a sole buying and selling agency has had a very beneficial effect upon the development of the pyrethrum industry. The details of the system will be discussed later (p. 42).

Prior to 1933 there are no statistics available regarding the areas planted and the production, but up till then it can be regarded as purely experimental. Since that date the development has been rapid, as shown by the figures in Table I.

TABLE I

Year.	No. of growers.	Area planted.	Production.		Export.	
		Acres.	*Tons.*	*Cwts.*	*Tons.*	*Cwts.*
1933-34	35	Less than 400	16	12	14	9
1934-35	126	1,908	79	11	77	7
1935-36	280	3,469	582	3	570	8
1936-37	341	4,624	1,041	12	975	16

As a result of collaborative work between Gnadinger and the writer, to be described in detail elsewhere, it appeared that very little Kenya pyrethrum reached the users containing less than 1·3 per cent. total pyrethrins. Kenya pyrethrum, by the middle of 1936, was already enjoying a premium, but this observation has led the Pyrethrum Board to offer pyrethrum with a guaranteed minimum pyrethrin content of 1·30 per cent., thus stabilising the premium.

CULTIVATION

Pyrethrum, *Chrysanthemum cinerariæfolium*, appears to demand a deep, well-drained soil. Generally in the pyrethrum areas these soils are lateritic red volcanic loams, but there are a few zones where the soils, red lateritic loams, are derived from other formations. It will grow on less well-drained soils, but, with the least amount of water-logging, becomes susceptible to disease attack. It is also intolerant of too rich soils.

In the early days of the industry only seedling material was used, and in the establishing of new plantings such material is still employed. The seed, as fresh as possible, as it tends to lose viability on storage, is thinly sown in a nursery bed provided with light top shade. If planted too thickly the seedlings suffer from damping off or have to be pricked out to a wider safe spacing, an operation which considerably increases the cost of planting.

Meanwhile, the field is prepared in the usual way, care being taken to clean it as much as possible from weeds. When the seedlings are four to six months old they are ready for transplanting. Throughout most of the pyrethrum districts this is done in April to May since a fair spell of wet weather can then be expected. All such transplanting is done by hand, no planting machinery has yet been used. The spacing employed varies considerably. Perhaps the favourite is 18 in. × 18 in., just under 20,000 plants per acre, but spacings as close as 15 in. × 15 in. and as wide as 30 in. × 24 in. are used. At one time the practice of planting three rows spaced 18 in. × 18 in. and then missing a row was common, thus a series of paths was formed which could be used in cultivation and picking. One of the main factors influencing the spacing interval is the prevalence of weeds. Although well-grown pyrethrum almost covers the soil it appears to be unable to compete against certain weeds, particularly *Galinsoga parviflora* and a recumbent species of *Oxalis*, which are able to grow within the dome-like mass of leafage. Indeed, in certain districts it is weed growth within the plant that limits the profitable life of a field of pyrethrum. The wider spacings are thus essential in districts where weed growth is at all strong in order to permit of the use of small hand-propelled cultivators as long as possible.

In common with most species of *Chrysanthemum*, pyrethrum is very readily raised from cuttings or splits of the parent plant, and now a very great proportion of Kenya pyrethrum is so propagated. Although the practice is deprecated in other pyrethrum growing countries as shortening the life of a plantation, no such trouble has been experienced here. On the contrary it has many advantages over propagation by seeds.

It is much quicker and cheaper, the splits being larger are more easily handled than seedlings, and further, there is no need for nursery beds. The plants developing from splits flower much sooner than seedlings; the latter seldom flower earlier than six months after planting, while splits have been seen to flower within a week; this is unusual, but normally a field planted from splits will be flowering within three to four months. Pyrethrum is very mixed in both vegetative and flowering characters. Vegetative propagation enables the grower to select and so eliminate plants with undesirable characteristics, shy flowering plants, and those with a tendency to produce recumbent flowering stems. There is one precaution that must be taken. Pyrethrum, as are some other species of *Chrysanthemum*, is self-sterile in Kenya, thus, in order for fertilisation to occur, the planting must be mixed. Too careful selection must not be practised. The most important characteristic, pyrethrin content, is not visible, and one may accidentally, by too stringent selection, light upon strains of low pyrethrin content. One strain, very free-flowering and carrying flowers over 2 in. in overall diameter, was unfortunately found to contain only 0·5 per cent. total pyrethrins.

As very well-grown pyrethrum almost completely covers the ground it is believed that it is a good anti-erosion crop. So it is when very well grown, but in its early stages it gives no protection and severe sheet erosion may occur. More and more pyrethrum fields are now being adequately protected by ridge terraces.

HARVESTING

Tattersfield [2] has shown, and his findings have been confirmed in other parts of the world, that as the flower head develops the pyrethrin content increases to a maximum when all the disc florets are open. At the same time, the weight increases considerably. Theoretically, flowers should be picked just about the time when the last florets are about to open. In experimental work this can be done, but on the commercial scale such picking would manifestly be impossible. In countries where there is one main flowering, there will be a variation in the age of some days, but it would be possible by reaping or clean picking to obtain an average harvest very close to the correct stage. In Kenya where flowering is

✓

practically continuous for ten months, April to end of January, a plant may carry every stage in development from tiny buds to over-mature flowers. In order to obtain a good average of mature flowers, therefore, picking must be adjusted according to the period it takes for the flower head to develop fully. The time it takes a flower head to pass from the stage where the ray florets are white but still vertical and unexpanded to that where the disc florets are all open varies considerably. Climatic conditions are the main factor. At altitudes of about 6,000 ft. in warm weather the whole of the opening may take as little as nine days, while at an altitude of 9,500 ft. in cool, misty, or rainy weather the time may be protracted to three weeks. It is thus incumbent on each grower to determine his picking period. That this is important may be exemplified by a simple case. Assume that during the main flush the period is ten days, under these conditions the opening of the disc florets is fairly regular. Considering picking done every ten and every twelve days, the following figures are obtained; flowers with two or fewer rows of disc florets open are considered immature.

	Picking Period.	
	10 days.	12 days.
	Per cent.	*Per cent.*
No disc florets open . .	10	8
Up to two rows . . .	25	20
Mature	65	64
Fully mature and over-blown	—	8

The general average of maturity and weight of individual flowers in the second case is much better than in the first. In view of the stringency of grading some growers place their picking periods two days longer than the opening period, others check the proportions of immatures at this period and adjust accordingly, while still others have trained their pickers to pick selectively. By such picking the average high pyrethrin content of Kenya flowers is maintained.

✓The usual daily task for an adult male picker is three *debbies* or 30 lb., any quantity over this being paid for at the rate of 10 shilling cents per measure (a *debbie* is a four gallon petroleum can, the universal tropical measure). The best pickers, however, are women and children, the men do not like the stooping entailed. That the task is well within the limits of the average picker is shown by the fact that some of the pickers total seven measures a day. Picking into the petroleum can is now being discouraged, the volume of the measure can be considerably reduced by judicious battering, and, more important still, flowers are liable to overheat and sweat. Most growers now use openly woven baskets. On well-run pyrethrum farms, as each measure is filled it is emptied into an open larger receptacle and the picker credited by the native overseer with a measure; thrice daily, at least, the flowers are transported to the drier so that danger of overheating and fermentation is reduced to a minimum.

YIELD

The yield varies according to altitude. At the lower limit of economic production, about 5,500 ft.-6,000 ft., the yield will be about 4 cwts. per acre, although local conditions at this altitude may send the yield up to 6 or 7 cwts. At the higher elevations, 8,500 ft.-9,500 ft., yields of 10-15 cwts. per acre are usual. In fact the writer was informed by a grower that during one month in 1936 he picked at the rate of 1,000 lb. of dry flowers per acre. Such a yield in one month appears fantastic. In the course of inspecting a well-grown field, the writer picked 108 mature blooms from a plant selected at random. Taking 140 mg. as an average weight for a dry flower, a conservative figure, ½ oz. of dry flowers were obtained from the individual plant. An acre population of 16,000 plants gives a generous allowance for misses, non-flowering plants, etc., thus a single picking of 500 lb. dry flowers could be obtained, or, with two pickings in the calendar month, 1,000 lb. The apparently fantastic yield, which candidly was regarded with grave scepticism, is thus quite possible.

There is a very great deal to be learned regarding the response of pyrethrum to variations in climate. The year 1937 was in many parts of Kenya exceptionally cold and wet, and flowering was retarded and depressed. It also appears that these conditions have been responsible for a decrease in the general average pyrethrin content.

Since only flower heads are picked, the plants become choked with dead flower stalks that interfere with the picking. When the flush of blooming drops to the point where it is difficult for the pickers to complete their tasks, it is the practice to cut the plants back to their vegetative shape, thus removing all trash and enforcing a resting period. Usually this cutting back occurs just at the onset of the dry season when the plants would normally pass into a resting condition. The subject of the intensity of cutting back is now under investigation. Already it appears that a definite degree of pruning is needed if the plants are to remain sturdy.

There are evidences that as a flowering flush proceeds there is a gradual decrease in the pyrethrin content. The figures obtained for the two last flushes at the Scott Agricultural Laboratories are shown in Table II.

TABLE II

Date of Picking.	Pyrethrins on dry basis.
	Per cent.
7-12-36	1·56
6- 1-37	1·36
1- 2-37	1·39
5- 5-37	2·00
6- 7-37	1·65
10- 8-37	1·54

If further investigations confirm these preliminary observations it may be necessary to cut back rather earlier in order to maintain the high pyrethrin content for which Kenya pyrethrum has become renowned.

✓The life of a plantation has been regarded as being dependent upon the weed and cultivation conditions only. In clean districts fields of pyrethrum six years old have shown no diminution in yield, but where weeds have established themselves within the pyrethrum plant there has been marked decrease by the fourth year. There is yet another factor that must be taken into account, a variation in pyrethrin content with age. Jary [3], at Wye, found decreasing pyrethrin content with successive crops, the first harvest contained 1·84 per cent. total pyrethrins, the sixth 0·87 per cent. The figures given in Table II above do not confirm these observations. The field, from which these flowers were picked, was planted partly in 1931 and partly in 1933, flowering for the first time during the year of planting. As there were two flowerings each subsequent year, the flowers gathered on May 5, 1937, represent what might be termed the thirteenth and ninth harvests, yet the dry flowers have a pyrethrin content of 2·00 per cent. Again, two series of samples taken at an interval of a month from fields of varying ages gave contradictory results, one series tending to confirm Jary's findings and the other not, as shown in Table III.

TABLE III.

Place and date of planting.	Total pyrethrins on dry basis.	
	1st series.	2nd series.
	Per cent.	*Per cent.*
Molo, 1931 (seedlings) .	1·38	1·46
Molo, 1933 (splits)	1·53	1·43
Molo, 1934 (splits)	—	1·44
Molo, 1937 (splits)	1·54	1·37
Njoro, 1933 (seedlings)	1·25	—
Njoro, 1935 (seedlings)	1·36	—

With such a mass of contradictions it is impossible to fix a time for the economic life of a field. A full investigation into the subject has been commenced, but as the results may not be available for five or six years, it appears that depression of yield by weed growth will for the time being have to remain the criterion.

DRYING AND PREPARATION

In drying pyrethrum the fresh flower loses 75 per cent. of its weight. The removal of this large quantity of water has introduced many problems.

In the early days of the industry, when individual plantings were a few acres only, it was fairly easy to dry the flowers in the sun or under cover. But now, when growers may have as many tens or scores of acres as once they had acres, different methods have had to be sought.

Aggravating the whole matter is the fact that the main producing areas are in a zone of heavy rainfall and some lie in the mist belt when, during the months of peak production, the countryside is enveloped in mist till well into the forenoon, and the sun may not be seen for weeks on end. Artificial drying under such conditions is essential.

There are many mechanical driers on the market that could very well be adapted to the drying of pyrethrum, but there is one very great objection to their use. They are all comparatively expensive, and are costly to operate. The problems before the Departmental officers and the industry were (1) the determination of the correct temperature for drying and (2) the evolution of a cheap, efficient drier which the grower could erect himself.

The first problem was soon solved, as it involved a number of analyses only. It was found that the maximum safe temperature for drying was about 130° F.; above this temperature there was a slight but appreciable loss, a finding since confirmed [4]. Incidentally, it was observed in the course of a study of the mechanics of a tunnel drier that if the early stages of drying were too rapid, the achenes of the immature flowers, which always occur in commercial pickings, are liable to case harden.

The second problem was far from simple, a good deal of experience was needed, not only in the mechanics of drying, but in the drying of the flowers themselves. Application of American tunnel driers has not been too successful; the most efficient take time to heat up and run well, and need to be run at full capacity to give complete satisfaction. Meanwhile, the growers could not wait till an efficient drier was evolved, and many types were designed by individual growers, some based upon no natural laws. The best and most widely used was the Oast House type. This was heated by charcoal braziers and should have been highly efficient. Unfortunately, however, all these oast house driers have passages down the middle, which act as flues carrying off the hot air before it has passed through the flowers; in fact, the air at the top of the building where it escapes, is relatively drier than that passing over a tray of nearly dry flowers.

At first it was possible only to suggest modifications of existing driers in order to make them more efficient. Gradually information was collected until finally the Ainabkoi Drier was evolved with the collaboration of Mr. R. O. Barnes. The drier first described [5] had a simple heating flue system which tended to give uneven heating. The flue system has since been considerably modified by Mr. Barnes, making the drier most efficient. As designed it will deal with a minimum of 1,000 lb. of wet flowers daily and costs £50-£80 to construct.

The principle employed in the Ainabkoi is upward natural draught of air heated by passing over a flue system. All the hot air is forced to pass through a series of trays containing the flowers. The successive passage of the hot air through the several trays has increased the efficiency very considerably. In view of the observations regarding the case hardening of the achenes of immature flowers, the trays containing the wet flowers are placed at the top where drying is less rapid. The trays, which are of wood with a ¼ in. wire mesh bottom, are evenly loaded at the rate of ¾ lb. of wet flowers per sq. ft. This gives a depth of about 2½ in.; as the flowers dry out they shrink until, when dry, they just cover the bottom.

The flowers treated in this drier have a very fine colour indeed, the original natural colours being unaffected. On account of the slow drying in the early stages flowers damp from dew or rain are not stained. In fact it is very much to be doubted if pyrethrum produced elsewhere has so attractive an appearance.

The correct stage of drying is reached when a flower squeezed between finger and thumb does not break up but does so if a rolling squeeze is given. At this stage it contains about 10 per cent. of moisture, and can be handled, packed and baled with very little damage. Over-dry flowers are very brittle and break up very badly on handling.

The flowers when dry are immediately packed in large kraft-paper bags, holding 50 lb. of dry flowers. Usually each bag when full is sealed by pasting on a paper cover. These paper bags have several advantages. They are cheap, are light but strong, saving an appreciable amount in railage, can be used several times, and above all are cleaner and easier to use than gunny bags. On arrival at the godown of the Kenya Farmers' Association (Co-operative), Ltd., the flowers are graded into the export and local grades detailed later (p. 43).

About a ton of flowers is bulked and mixed together in a large hopper, whence they pass to the hopper at the baling press. As the flowers enter this hopper a sample of a definite quantity is drawn.

The cage of the hydraulic baling press is lined with kraft-paper and hessian cloth before filling. Four cwts. of dry flowers are run in and the bale compressed to a standard size of 22 × 20½ × 37 in. under pressures varying from 4,200 to 5,800 lb. per sq. in., the drier the flowers the greater the pressure needed to reach the necessary size. After the pressure is released the bale expands during the process of banding to the final dimensions of 24 × 22½ × 37 in., approximately 12 cu. ft. After banding, the bales are covered with jute hessian cloth. The pressures employed are rather less than those used in Japan and the packed pyrethrum is consequently not so hard as Japanese. This has been favourably commented upon by users.

The samples drawn from individual bales are bulked (usually 125 samples are combined) and well mixed. From the bulk, by successive quartering, a laboratory sample is drawn representative of the 125 bales (25 tons). Total pyrethrins are determined at the Scott Agricultural Laboratories by the copper reduction method of Gnadinger and Corl [6]. Upon the results of this analysis is based the guarantee which refers to that lot of 25 tons.

It might not be amiss here to indicate why the copper reduction method has been accepted as standard in Kenya. It is a difficult and laborious method, very sensitive to traces of dust or even certain fumes. In the two most widely accepted "acid" methods the determination of Pyrethrin II involves extraction with ether. The altitude of the Scott Agricultural Laboratories is just under 6,000 ft. and ordinary ethyl ether boils at about 28·5° C.; air and water temperatures of over 25° C. are common. Continuous extraction, as in the Tattersfield method [7], is expensive in ether on account of inefficient cooling, whilst shaking with ether as needed in the Seil method is apt to be dangerous on account of the high pressures developed in the separating funnel after shaking. In order to employ either of these methods special equipment would be needed, which, up to the present, it has not appeared necessary to instal. Should the demand for the assay to be done by the Seil method become strong enough it will be incumbent on us to instal such equipment.

ORGANISATION

The Kenya Pyrethrum Growers' Association during its three years of existence did a very great deal to establish the industry on a firm foundation. During its life the export of pyrethrum was started, and, in order to facilitate this, arrangements were made with the Kenya Farmers' Association (Co-operative), Ltd., for the installation of a powerful hydraulic baling press. The Association was, however, not fully representative, and had no statutory powers for the regulation of sales, the institution of grading rules or the control of the industry.

As a result of representations made by the industry the "Sale of Pyrethrum Ordinance, 1935," was enacted. Under this Ordinance an agency was established through the hands of which all pyrethrum must pass. A board of control was also instituted, and, since every pyrethrum grower is forced to register himself, the board, being elected by the growers, is representative of the whole industry. The Kenya Farmers' Association (Co-operative), Ltd., were appointed the local agents, to receive, grade, pack, and sell the pyrethrum. The large and wide organisation of this firm is admirably suited to the purpose. In addition the Pyrethrum Board have appointed a sole agent in London for the sale of pyrethrum outside East Africa.

Under the provisions of the Ordinance growers must supply estimates of their crops. Upon these estimates forward sales are made. Thus the pyrethrum is despatched to the user without any delay. There is no accumulation of stores; the pyrethrum reaches the buyer in as fresh a state as is possible.

Another function of the board and the agency instituted under the Ordinance is the grading of pyrethrum. At first there were only two grades, based upon appearance. Later, when it appeared that the quality of Kenya pyrethrum was deteriorating, new grades were laid down, depending on the proportion of immature and over-mature flowers. The present grades, as revised in February 1938, are as follows:

> *Grade* 1 (*Export*).—Pyrethrum flowers of good colour containing not more than 33 per cent. immature flowers and/or 8 per cent. buds, and/or 10 per cent. discoloured flowers, and to be free from foreign matter.
>
> *Grade* 2 (*Local*).—Pyrethrum flowers of fair colour, containing between 33 and 50 per cent. immature flowers and/or 12 per cent. buds, and/or between 10 and 25 per cent. discoloured flowers, and free from foreign matter.
>
> *Grade* 3 (*Local*).—Pyrethrum flowers of reasonable colour containing between 50 and 75 per cent. of immature flowers, and 25 per cent. buds, and/or 25 to 50 per cent. discoloured flowers, and free from foreign matter.
>
> Flowers below Grade 3 are rejected.

Definitions

✓ Immature flowers are flowers which have less than two rows of disc florets open at the time of picking. ✓

Discoloured flowers are flowers which have passed the full blown stage.

Suppliers of second and third grade flowers of course receive less for their product than the suppliers of first grade flowers. As a result of the more stringent grading rules and the lower payment, there has been a marked improvement in the general quality.

There is no doubt that the organisation developed under the Sale of Pyrethrum Ordinance, 1935, has played a very great part in the development of the industry, and in the establishment of the very great reputation Kenya pyrethrum enjoys throughout the world.

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THE CASHEW NUT INDUSTRY IN WESTERN INDIA

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In Europe cashew nuts are frequently used for decorative and flavouring purposes in the baking and confectionery trades. They form a common ingredient of many varieties of cakes and sweetmeats which are popular in Western countries. As "salted nuts," they are even more familiar in the United States of America. In flavour and in nutritive value, cashew nuts compare very favourably with almonds for which they are sometimes substituted in the preparation and decoration of cheaper grades of confectionery.

The cashew nut tree (*Anacardium occidentale*) is now to be found in many parts of the World. Originally a native of South America, it was introduced into Asia and Africa by early Portuguese travellers. At the present time cashew nut trees grow extensively in tropical America, from Mexico to Brazil, and in the adjacent islands of the West Indies. They flourish in the forests of East and West Africa and in Madagascar, in Indo-China, the Malay Peninsula, and in the Philippine Islands. Along the coastal tracts of Western and Southern India the cashew nut tree, with its luxuriant dark-coloured foliage, is common in the forested hill regions where the warm and humid atmospheric conditions favour its natural development and spread. Like its near relation, the mango tree (*Mangifera indica*), it thrives well in the vicinity of the sea and is a prominent feature of the scrub jungles of the Konkan, that interesting and fertile strip of country which forms the coastal boundary of the south-western districts of the Bombay Presidency. This tract consists of an elevated plateau, intersected by numerous rivers and creeks. It is subject to heavy rainfall, varying from 90 to 150 in. annually, all of which falls during the four monsoon months of June to September. The climate is equable during the short cold weather season, but, for the greater part of the year, hot and humid conditions prevail.

As a general rule, cashew nut trees, locally called "kaju," grow wild in the Konkan forests and little or no attempts are made by the Indian cultivators to establish them in cultivated plantations. In a few places seedling trees are planted as "hedge crops" on the borders of cultivated lands, but systematic plantation is seldom practised. It is a common belief among the Konkan farmers that no crop will flourish in the neighbourhood of a cashew nut tree, which is supposed to have a peculiarly exhaustive or toxic effect on the soil. There does not appear to be any scientific basis for such an opinion. Cashew nut trees thrive best on light, sandy soils, but they grow well on the shallow, lateritic slopes which constitute the "varkas" or inferior hillside lands on the spurs of the Western Ghats. The produce of the trees is gathered by the poorer cultivators in these jungle tracts, to whom the fruit, timber, and oil yield a welcome addition to a scanty income derived from a primitive system of rice cultivation.

Under favourable conditions, the cashew nut tree, though somewhat ungainly in habit, grows to a height of 20 to 30 ft. and bears a thick foliage of dark coloured broad leaves. In the Konkan tract it flowers in January or February, and the peculiarly-shaped fruits ripen about two months later. Fruit-bearing commences at the end of the third year. The true fruit or cashew nut attains its full size in a very short time and can be seen hanging from the branches in dark green clusters. After the formation and ripening of the nut, a strange phenomenon takes place. The stalk or peduncle of each nut gradually swells and assumes a fleshy, turgid appearance, somewhat resembling an overripe apple. This cashew "apple" matures to a bright red or yellow colour, a striking contrast to the dark olive-green nut which projects as a kidney-shaped excrescence from the apex of the rounded and pulpy "fruit." These cashew "apples" are collected by hand in April or May and the nuts are separated from the swollen stalks in the huts of the villagers. In the Konkan a mature cashew nut tree of eight to ten years old will yield from 100 to 150 pounds of "apples" annually, from which about 20 to 25 lb. of unhusked nuts are obtained. The local value of the produce of a well-grown tree is approximately Rs. 2 to Rs. 2-4, or about 3*s.* 6*d.*

After the cashew nuts have been collected they have to undergo several processes before they are ready to be marketed as the "blanched cashew kernels" of commerce. The most important of these after-treatments is roasting, which not only facilitates the extraction of the kernel from the hard, outer husk, but which also renders the kernel more palatable and fit for human consumption. In the jungle villages primitive methods of carrying out this process have been in use for many years. The entire nuts are placed in earthenware pots which are perforated on the base to permit the escape of the pungent, astringent oil released from the husks during the roasting treatment. These pots, each containing about 1½ to 2 lb. of nuts, are balanced on three stones over a slow burning fire, fed with dry cowdung fuel and dead leaves. While heating, the nuts are stirred with wooden ladles and the expelled oil, which drains through the holes in the base of the pot, is collected in an iron spoon. This work is almost invariably done by women, who, by long practice, have acquired much skill in the process. After about 10 minutes roasting the nuts are ready for separation. They are placed in a basket and sprinkled with wood ash, so that the oil with which they are covered will not adhere to the hands of the workers.

This precaution is very necessary as the oil contained in the husks, and given off during the roasting, is injurious on account of its vesicant properties, due to the presence of an astringent substance known as "cardole," which has a similar action to crude carbolic acid on the human skin. The husks are then cracked between two stones and the kernels are extracted by hand. No efficient mechanical device for this separation has yet been evolved in spite of the development of the cashew nut industry on a factory basis in several centres of the district. In the adjoining regions of Kanara and Portuguese India, i.e. Goa, a method has been adopted whereby the cashew nuts are roasted in hot sand prior to the extraction of the kernels. This process results in a greater percentage of oil being left in the kernels than by the "pot" method. Consequently, kernels roasted by the "sand" method are never so sweet or palatable as those prepared by the original and more primitive village system.

In the Konkan districts of the Bombay Presidency, and in the adjoining Portuguese territory of Goa, several factories have now been established for the large-scale preparation of cashew nuts for export markets. These factories deal with very considerable quantities of nuts annually. As the local supplies are at present inadequate for factory requirements, large imports of raw, unhusked cashew nuts are made each year from Mozambique, Zanzibar, and the East African ports for processing in the Indian factories. The roasting and pre-treatment of the nuts before export is a highly technical business requiring considerable skill and experience on the part of the labourers employed in this work. Accordingly the districts mentioned above have acquired a virtual monopoly in the preparation of "blanched cashew kernels" from the raw material and a thriving and profitable industry has been built up at such centres as Malvan, Vengurla, and Goa, where cheap but skilled labour is readily available.

A visit to a cashew nut factory is a most interesting experience. The raw unhusked nuts are brought to the factory godowns in headloads or in bullock carts by the local jungle dwellers who have collected them in the neighbouring forest areas. Imported nuts are transported in "dhows" or country sailing craft from East African ports to the Konkan coastal towns. On arrival at the factory the nuts are roasted in large open pans or in perforated rotary drums suspended over flaming fires fed with the oily and inflammable dry husks as fuel. This roasting process lasts from one to two minutes and about 8,000 lb. of nuts are roasted in each pan daily. When the rotary drum method is used, the nuts are soaked overnight in water before being fed into the drums next day for roasting. This preliminary soaking softens the hard outer shell and enables the roasting to be done without burning the nuts, which often occurs in the "open pan" system. The drums are 12 ft. long and 3 ft. in diameter and are usually made of galvanised iron sheeting. They are geared to a turning mechanism worked by hand and are fixed in a sloping position above the furnace. During roasting the nuts are fed in continuously at the upper end of the cylinder, which is revolved rapidly or slowly according to the intensity of the fire. As the drum revolves the nuts gradually roll through the interior, getting adequately roasted on the way, and are finally discharged from the open lower end. The pungent oil which is given off by the husks during roasting drains into a separate collecting receptacle. The roasting room is full of the oily smoke and acrid smell of the burning husks which have a most unpleasant effect on the nose and eyes of the unseasoned visitor.

After roasting, the nuts are dusted with wood ash and removed in flat, shallow baskets to a large shed where the husks are broken open and the kernels extracted. This work is done entirely by women and girls, who squat on the floor and crack the roasted nuts with small wooden batons on flat stones embedded in the ground in front of them. Considerable skill is required to carry out this operation quickly without damaging the kernels and thereby reducing to a very great extent their commercial value. Twenty-five lb. of unhusked nuts yield from 6 to 8 lb. of kernels. The kernels, when extracted, are covered with a thick yellow skin which must be removed before packing for export. To facilitate the removal of this outer integument, the kernels are subjected to baking in drying chambers at a temperature of 70° C. for four to six hours. As a result of this treatment the yellow outer skin dries up and shrivels and can be easily and completely removed by hand, leaving the ivory-white and shining surface appearance desired by the trade. During this drying process the kernels become brittle and would easily be damaged and broken in packing and transport. Accordingly they are now subjected to a " sweating " treatment which is carried out with the object of enabling the dried kernels to absorb moisture and thus prevent excessive breakage and chipping in subsequent handling. For this purpose the kernels are spread out in a single layer on long flat trays, which are placed in " sweating chambers " over small tanks of water. The necessary moisture is absorbed by the kernels after about two or three hours of this treatment, when they are removed to another part of the factory for grading and packing for export. The kernels are graded by skilled female labour, according to size, and are then packed in tins, each containing 25 lb. of kernels. The air contained in the packed tins is exhausted by means of a vacuum pump and replaced by carbon dioxide to prevent the subsequent development of moulds on the produce. The tins are then hermetically sealed, labelled, and packed in wooden crates for export.

The cashew nut factories of the Konkan work for about ten months of the year and the great bulk of the production of Indian " blanched cashew kernels " is exported to the United States of America. About 15,000 tons of raw, unhusked nuts are imported into India annually for preparation in the Indian factories and are re-exported along with the locally-grown produce. Such imports are mainly from Portuguese East Africa, Kenya Colony, and the Union of South Africa. In 1934-35 the export of " blanched cashew kernels " from India to America was approximately 5,300 tons, which increased in 1935-36 to 7,700 tons. Exports to the United Kingdom and to the Continent in these two years did not exceed 270 and 750 tons respectively, and, accordingly, it is obvious that the industry depends at present almost entirely on the demand of the American consumer. Unfortunately signs are not wanting that this demand is on the decline and is being further restricted by adverse tariffs. It is therefore essential in the interests of the Indian cashew nut industry that new markets for this nutritious and useful product should be developed in other parts of the world, especially in the British Empire. The annual export of cashew nuts from India represents a cash value of over 50 lakhs of rupees, i.e. £385,000, and the industry gives employment to 10,000 to 15,000 people during the season.

The Agricultural Department of the Bombay Presidency has recently been conducting scientific research work on the possibility of establishing cashew nut tree plantations on the "varkas," or uncultivable hill-slope lands of the Konkan tract. These lands are shallow and rocky, covered with a thin layer of red laterite soil which is very liable to erosion in the rainy season. In general, they are unfit for crop cultivation except for patches of inferior millets which are grown during the monsoon in small pockets of deeper soil in gullies and ravines. An experimental plantation has been established near Ratnagiri where the technique and economics of cashew nut tree planting are being carefully worked out. The importance of such work lies in the fact that there are approximately 350,000 acres of such "varkas" lands in the south-western districts of the Presidency, which, at present, yield practically no return to their owners or to Government. When cashew nut trees are cultivated, either as hedge crops or in regular plantations, the best method has been found to be that of sowing the seed *in situ*. The more usual method, adopted with most tree plantings, of preparing seedlings in nurseries and subsequent plantation, does not give good results with the cashew nut tree. This tree in its early stages develops a strong tap root, which transplanting is liable to damage. Trees grown *in situ* stand drought well and are less likely to suffer from deficiency of water or from high winds than those grown from transplanted seedlings. The latter are often stunted in development and give lower outturns of fruit when mature. For the establishment of a cashew nut tree plantation *in situ* three or four seeds are planted in small pits, 20 to 30 ft. apart. These pits are usually dug by hand, but, owing to the rocky nature of the soil, this is a most laborious task and the possibility of utilising explosives for their preparation is under investigation. When the young trees are about nine months old the best plant in each pit is retained, the others being uprooted. The plantations require to be artificially irrigated during the first two years, but thereafter cashew nut trees require no special care or attention as the leaves are not eaten by cattle and they are unaffected by any serious insect pest or disease. No subsequent manuring or pruning is necessary. The plantations will not flourish on exposed situations, but prefer low altitudes and sheltered positions, preferably on porous laterite soil.

No description of the cashew nut tree and the industry dependent upon it would be complete without some mention of the valuable by-products which the tree yields in addition to the kernel of commerce. To begin with, the cashew " apple," or the swollen peduncle upon which the true fruit is borne, has hitherto been regarded as of little economic value. Before the passing of the Indian Abkari Act it was often utilised by the jungle " bootlegger " for the preparation of an intoxicating liquor. The " apples " were crushed under foot and the extracted juice was fermented for several days and distilled in a country still or " lawni." About 8 gallons of distillate were obtained from 40 gallons of juice. More recent—and more lawful—attempts have been made to prepare vinegar from the cashew " apple," but, so far, such experiments as have been conducted in British India do not give much promise of economic utilisation in this direction. In the Portuguese territories of Goa the preparation of liquor from the cashew " apple " is carried on within the law and under Government control. In this connection it is interesting to note that the early chroniclers of Brazil make mention of a " fragrant and delicious wine " prepared from the cashew tree. Investigation into the profitable and economic uses of the cashew " apple " is a matter of great importance, as it is essential that the bulky and juicy peduncles of the nuts should be utilised on a commercial scale if the organised and systematic plantation of the tree is to be established and extended in India.

The cashew oil, which is extracted from the shells of the raw nuts during the process of roasting, has many valuable uses. At one time it was employed only by the natives, but much work has been done in recent years with a view to its industrial utilisation. Processes have been devised for using it in the preparation of different kinds of varnishes, insulating coatings, moulding compositions, inks, etc. During 1936 large quantities of the oil were exported, principally to the United States and Germany, and one company with factories near Quilon is planning to produce 200,000 gallons of shell oil annually. In view of the growing demand for the oil new methods for its extraction are being developed so as to prevent the large wastage incurred in the ordinary treatment of the nuts.

In India, where the shell oil is sold locally at the rate of Rs.

1-8-0 per maund of 28 lb., it is in demand as a lubricant for country boats and has the valuable property of preventing damage by white ants when painted on furniture, books, and similar perishable articles. The oil is also used by fishermen as a preservative for their nets. The villagers maintain that cashew shell oil is a valuable specific against leprosy, that dreaded scourge of the East, and there is evidence from medical men in the districts that the oil is efficacious in the treatment of this disease.

The resinous gum exuded from the bark of the tree has well-known insecticidal properties and is also used as a tanning agent. The sap obtained from incisions in the bark is utilised as an indelible marking ink. Finally, the wood of the tree is a common fuel in the regions where it is obtainable, and it is also utilised for the manufacture of country boats, packing cases, and in the preparation of charcoal.

THE COPPER INDUSTRY OF THE U.S.S.R.

THE production and consumption of copper in the U.S.S.R. have expanded considerably in recent years, but in view of the fact that relatively little information regarding the copper situation in the Soviet Union is readily available to English readers, the following statement, compiled mainly from recently-published Russian and German articles, may prove interesting to those concerned with the copper industry in Empire countries.

The copper industry in the Soviet Union is under the control of the Commissariat for Heavy Industry. Until recently it was administered, within that Commissariat, by the Central Board for Non-Ferrous Metallurgy (Glavtsvetmet), but in November 1937 this Central Board was separated into two independent Boards, one of which, Glavmed, now deals exclusively with the copper industry.

Varying estimates are published from time to time as to the extent of Soviet copper resources, the latest and largest being about 17 million tons of metal. The most extensive deposits of copper ore occur in Kazakstan, the two main groups being the Kounrad ores near Karsakpai and the Balkhash ores near the northern shore of Lake Balkhash. The Urals also contain considerable deposits of copper ore, and other deposits occur in Uzbekistan, Bashkiria, Middle Volga, West Siberia, Transcaucasia, Leningrad Province and the Kola Peninsula.

Production is still comparatively small in view of the vast resources, but it has more than doubled since 1933, and strenuous efforts are being made to increase production still further. During the last few years the Soviet Union's need for copper, owing to rearmament, electrification and rapid industrial development, has increased at a greater rate than production, and imports on a large scale are still being effected. The huge works now projected or in course of construction suggest, however, that within a few years the Soviet Union will not only be able to supply all its own requirements but will be in a position to enter the export market on a fairly large scale.

Before the revolution, copper production in Russia was almost entirely in the hands of foreign firms, mostly British, and the output of black copper in 1913 was about 29,000 tons. The works were comparatively small, situated in the Urals, Transcaucasia, and Kazakstan, and, at that time, only ores with a comparatively high copper content were worked. During the war and subsequent civil war production fell to very low levels, but between 1922 and 1930 most of the pre-war works were once more put into operation and the construction of new ones was put in hand. In 1930, 44,600 tons of black copper was produced, of which 34,100 tons was smelted from ore.

The principal change in recent years has been the transfer to low-grade ores, and the construction of huge works where most of the production processes are mechanised. The flotation process of concentration, it is claimed, has now been mastered, and the technical equipment of the works now under construction is claimed to be equal to that in the United States, whilst some of the new works will be larger than any at present existing elsewhere. In spite of the good technical equipment of the works, however, it is admitted that the efficiency level is still well behind that in America, and that the proportion of metal extracted is far too low. A conference of copper technicians was called at Sverdlovsk in November 1937 by the Commissar for Heavy Industry, Kaganovitch, at which attention was drawn to many of the shortcomings of the industry. Apart from hindrances due to slackness and inefficiency, one important source of trouble is the extensive underground fires, particularly in the Urals, which Soviet fire-fighting technique seems unable to overcome, and which not only results in loss of life and constant danger to workers, but also leads to the permanent loss of valuable resources.

Copper production in 1936 amounted to about 100,000 tons, and imports during the same year were over 45,000 tons. The planned production for 1937 was 145,000 tons, against probable requirements of 175,000 tons, but actual production seems unlikely to be much higher than in 1936. Imports in the first nine months of 1937 totalled 50,706 tons, against 34,057 tons in the same period of 1936.

Construction of the new works seems to be proceeding very slowly, and some of the " giants " projected some years ago still exist only on paper. A big step towards increased production has been taken by the linking up of two of the main producing areas, the Karsakpai and Balkhash deposits, by rail with Karaganda.

The more important new works, under construction or projected, are :

(1) The Balkhash plant. Construction of this plant was begun in 1930, and although 300 million roubles have been spent on construction and equipment no copper has yet been produced. The first section of the plant is designed to produce 35,000 tons of black copper per annum, and the total eventual output is to be 100,000 tons per annum. It was planned to produce about 12,000 tons in 1937, but as recently as December 10 it was announced that the first section of the concentration plant was only then about to be put into operation.

(2) The Jezkazgan plant at Karsakpai in Kazakstan. This plant, which will work on low-grade ores (metallic content about 1·6 per cent.), is designed to produce eventually 200,000 tons of black copper per annum. It will be three or four years, however, before production is even begun.

(3) Sreduralmedstroi, the Mid-Ural copper plant. The first section of the concentration plant, treating 2,400 tons of ore a day, was completed early in 1937. The eventual capacity of the concentration plant is 14,000 tons of ore a day, and of the plant as a whole 50,000 tons of copper a year.

(4) Bliava in the Middle Volga region. This plant was expected to start operations in 1937 and to produce up to

5,000 tons of copper in that year. So far as is known it is not yet completed. Its eventual output capacity is stated to be 35,000 tons. It is also proposed at this plant to produce sulphur by the Norwegian patented " Orkla " process.

(5) A nickel-copper plant under construction at Monchegorsk in the Kola Peninsula.

(6) A projected plant to produce 100,000 tons of copper a year on the Central Asian ore deposits near Tashkent.

It will thus be seen that, adding present production of copper to the scheduled output of works under construction or proposed to be constructed in the next few years, the Soviet Union is planning for an eventual output, say within the next ten years, of about 500,000 tons of copper per annum.

Electrolytic copper is produced at present at the Ural works of Pishmin and Kishtin, the former having a potential output capacity of 100,000 tons per annum.

The following further details have been extracted from articles published in the Russian journal *Tsvetnie Metalli* (Non-ferrous Metals) No. 11, 1937 and *Der Ost-Express*, Berlin, December 1937.

The U.S.S.R. reserves of metallic copper in ore were estimated on January 1, 1935, to be as follows:

District.	*Tons.*
Kazakstan	6,404,400
Urals	2,116,500
Uzbekistan	1,285,400
Bashkiria	330,500
Middle Volga	324,500
West Siberia	108,600
Caucasus	52,400
Leningrad Province	8,300
Karelia	4,900
Total	10,635,500

[Later estimates, however, have placed the total at over 17 million tons (*Metal Bull.*, December 29, 1936, p. 4).]

The new discoveries of ore in the Kounrad area made possible the construction of the Balkhash plant. These deposits are estimated to contain over 2 million tons of copper, but they are located in a desert region where neither drinking water nor coal is available. On the other hand, the ores, which have a metallic content of 1 to 2 per cent., can be quarried, which is a great advantage.

At Jezkazgan the former British proprietors worked on known resources of 70,000 tons and only extracted the richer ores. The deposits are now estimated at 3·7 million tons, and further investigations are expected to reveal that the ore deposits are much larger even than this figure, and that they equal in extent the world's richest deposits in Central Africa.

A further large deposit of copper ore, estimated at about 2 million tons, has been located at Boschekul in Kazakstan.

In Central Asia, about 60 kilometres from Tashkent, extensive copper ore deposits have been discovered, and, as already mentioned, it is proposed to build a plant there to produce 100,000 tons of black copper annually. Even in the Allaverdi area in Transcaucasia, where the deposits were supposed to be on the verge of exhaustion, further ores have been found, and still further resources of copper and molybdenum have been revealed at Pirdaud and Agarak in Transcaucasia.

The Bliava deposits in the Middle Volga, discovered in 1933, are rich in copper, silver, lead and gold ores as well as sulphur. The copper ore resources are estimated at 150 million tons, the ores having metal contents up to 4 per cent. Preparatory work is progressing very slowly.

The Sredneural deposits at Degtiar, the largest in the Urals, are estimated to contain about 900,000 tons of copper (1·1 to 2 per cent. content of ores). Work is progressing very slowly and at present only raw ore is being extracted.

Copper will also be produced at the Altai Polimetallic Combine, where the ores are very complex.

Other deposits as yet unworked are known to exist, e.g. at Sokurkoj (3 to 5 per cent. copper content) and Bostche-kul in Kazakstan (1 to 6 million tons), Chakassk-Minussinsk in West Siberia (830,000 tons), Almalyk in Central Asia (900,000 tons), Agarak and Pirdaud in Transcaucasia (1,200,000 tons), in the Donetz Basin, etc., and these constitute an ample reserve for the future.

Progress in the production of copper ore is shown by the following figures:

Year.	*Metric Tons.*
1922-23	60,132
1925-26	408,775
1929-30	919,367
1933	1,332,848
1934	2,084,189
1935	2,790,571
1936	3,562,160

Copper ore production in 1913 was 1,118,000 tons, and it was not until 1931 that that figure was again almost reached, but by 1936 the output had grown to 3,562,000 tons. In the course of the third five-year plan which commences this year, it is proposed to increase the output in the Kounrad area alone to 14 million tons per annum, and in the Degtiar area (Middle Urals) to 4½ million tons per annum.

Most of the mining will be effected by the system of top-slicing and sub-level caving, and all processes including the transport of ores to the concentration works will be mechanised. In the Degtiar mines ore will be transported by electric traction in trucks of 5 or 6 tons capacity, and workers will be carried in electric cars similar to tram-cars. Diagonal ventilation and compressed air supply systems will be employed. The average output of ore per worker per shift is expected to be 3·27 tons, and the estimated cost 5·25 roubles per ton.

The production of copper in the Soviet Union, together with the imports since 1930, are shown below:

U.S.S.R.—PRODUCTION AND IMPORTS OF COPPER
(thousands of tons)

	1930.	1931.	1932.	1933.	1934.	1935.	1936.	1937.
Black Copper . .	44·6	44·3	45	44·3	53·3	75·4	99·6	130 (Plan)
of which extracted from ores . .	34·1	31·6	32·1	32·7	44·1	63·2	83·3	(*a*)
Electrolytic Copper .	(*a*)	(*a*)	(*a*)	(*a*)	16·8	40	(*a*)	(*a*)
Copper Imports. .	20·7	25·3	12	7·8	11	29·6	45·3	23(*b*)

(*a*) *No figures available.* (*b*) *Six months only.*

During the last ten years copper concentration plants have been completed at Krasnoural, Kirovgrad, Pishmin (electrolytic) and Karsakpai.

The first copper smelting plant of Soviet construction was that at Karsakpai, in the " hungry steppes " of Kazakstan, 400 km. from the nearest railway. It was built in 1926-28 and exploitation was begun in 1929, reverberatory furnaces being used. Difficulties were at first experienced owing to the siliceous nature of the local ores with pyrites content, but these were overcome and the valuable experience gained will be used at the Balkhash works and at the Jezkazgan plant.

The Krasnoural plant was equipped according to the latest American technique, and began partial exploitation in 1931. The flotation method of ore concentration is used; the concentrates are roasted in Herreshoff furnaces and then smelted in reverberatory furnaces, waste gases being used to produce steam and electric energy. Pierce-Smith converters are also used, and the Cottrell system of dust-removing. The Karabash and Kirovgrad smelting plants were reconstructed and enlarged at the same time. The Ural ores, which are poor and have a high iron content, require modifications of the American system, and these are being partially applied, but metal extraction is still 8 to 10 per cent. lower than American standards. The Ural plants increased their output fivefold between 1927-28 and 1936, and in the same period the Transcaucasian works at Allaverdi and Zangezur doubled their output, although Allaverdi has not yet reached the pre-revolution rate of production.

The tonnages of copper produced at the main plants in the years 1934 to 1936 were:

District.	Works.	1934.	1935.	1936.
Urals	Kirovgrad	12,011	17,772	22,996
,,	Krasnoural	10,640	17,515	22,840
,,	Karabash	9,645	15,471	20,128
Kazakstan	Jezkazgan	3,945	4,376	6,388
Bashkiria	Baimak	4,311	4,287	4,759
Caucasus	Allaverdi	2,140	2,303	4,744
,,	Zangezur	1,389	1,623	1,501
		44,081	63,347	83,356

Secondary copper is produced from waste and scrap at the Molotov, Krasny Vyborzhtsi, Podolsk and Metalloprokatni works.

Plans are also being formulated for exploiting the extensive deposits of Uzbekistan at Almalik by the hydrometallurgical system.

Before the war Russia's annual output capacity of electrolytic copper was 17,707 tons. In 1930 the construction was begun of the Pishmin electrolytic works, the first section of which, with a capacity of 100,000 tons, was completed in 1934. The gold and silver obtained from electrolysis of copper is now extracted at the Kyshtim works, whereas before the revolution this process had to be performed abroad.

The following table shows the metallic content of ores and concentrates at some of the leading Soviet copper works, and also the percentage of metallic copper extracted:

Works.	Copper Content. *Per cent.*		Percentage of copper extracted.
	Ore.	Concentrate.	
Karabash	2·7	14—16	92—94
Krasnoural	2·5	9·5—10·5	85·5—92
Zangezur	—	15—18	91—93
Jezkazgan	3·5—5	24—25	90—92
Kirovgrad	3—3·5	12—15	82—90

As already mentioned, the new plant to be built at Jezkazgan will treat ore with a metal content of 1·6 per cent.

The article in *Der Ost-Express* reviews the difficulties which are being encountered in developing the Soviet copper industry and points out that it is remarkable that in spite of the extensive deposits and the enormous capital investments in new works (e.g. in the second five-year plan 370 million roubles for the Balkhash and 169 million roubles for the Sredneural works, etc.), copper production is still so low that the Soviet Union has to import large quantities of the metal. Various decrees, regulations and conferences have attempted to deal with this problem in the last few years, and the conference called at Sverdlovsk in November 1937, which discussed the very unsatisfactory results of the industry, brought to light the following matters:

The Ural works, which produce about four-fifths of the present copper output, had only fulfilled about 50 to 60 per cent. of their programme in the first nine months. Among the reasons given were (1) transfer to poorer ores, (2) slack execution of preparatory work, (3) underground fires, (4) stoppages due to damage or accidents, (5) low smelting output, (6) heavy loss of metal in concentration and smelting processes, and (7) delayed deliveries by Soviet machine shops of flotation and mining equipment.

The copper content of ores worked fell from 5·08 per cent. to 2·94 per cent. between 1929-30 and 1934, thus necessitating the treatment of double the quantity of ore. The forthcoming exploitation of the low grade Kounrad ores represents a further step in this direction.

The underground fires, which have been most extensive, not only lead to stoppages but destroy enormous quantities of ore besides being a constant danger to the miners. Some of these fires have lasted for years, and have broken out again after apparently having been completely extinguished—in one case, in fact, after the workings had been under water for four years.

Thousands of tons of copper are lost annually in concentration plants and smelting works, where only about two-thirds of the metal is normally recovered. At the Krasnoural works in the first half of 1936, the metal extraction was only 54 per cent. In 1935 the Ural works extracted, in the smelting process, an average of 85 per cent. of metal, whereas the best American works extract 94 to 99 per cent. The copper content in a furnace slag at Krasnoural was 0·65 per cent. against an average in U.S.A. of 0·2 to 0·27 per cent.

NOTES

Obituary. Dr. Ernest Goulding.—With the greatest regret we record the death, at the age of 67, of Dr. Ernest Goulding, D.Sc., F.I.C., late Vice-Principal of the Plant and Animal Products Department of the Imperial Institute. Dr. Goulding joined the staff of the Imperial Institute 42 years ago and retired in 1935. An account of his services was published in this BULLETIN, 1935, No. 3, p. 352.

Subsequent to his retirement Dr. Goulding delivered at the request of the Textile Institute, the Mather Lecture for 1936.

Exhibition Galleries.—In continuation of the scheme for making the Exhibition Galleries a "Storyland of Empire," several of the older exhibits have been recently overhauled and rearranged on story lines, whilst in the case of the new exhibits which have been installed this scheme has also been kept in view.

In the Indian Court, specimens, photographs, and miniature models have been arranged to tell the story of tea from the seed, through the stages of cultivation, plucking, and manufacture, to the various grades of Indian tea-leaf as marketed in the grocer's shop.

An additional series of specimens, presented by the Mycalex (Parent) Co., Ltd., has been added to the Indian mica exhibit. These specimens illustrate the compounding under great heat and pressure of pulverised mica and a pulverised special glass to form a composition, "Mycalex," possessing all the good insulating qualities of mica with the additional merit of being easily machined (sawn, drilled, turned, etc.) and also moulded. Examples of machined Mycalex as used in radio transmission equipment are also shown.

Two new dioramas for the Indian Court have recently been made in the Imperial Institute studio; one dealing with the production of tobacco in India has been designed and executed by Mr. R. T. Roussel, and the other illustrating sugar-cane and the preparation of sugar is by Miss Jane Jackson. The descriptive label for the former reads as follows:

Tobacco Production in India

"This diorama represents the cultivating and curing of good quality cigarette leaf tobacco on small holdings in the Guntur district of the Madras Presidency.

"To the left of the scene is a river which annually overflows the fields on either side leaving a silt as the flood retires, in which the tobacco has been planted. In the foreground the plants are realistically modelled, the plantation gradually merging into the painted scene in the rear where plants have been left to flower and ripen seed for later crops. In the centre women are busy stripping the matured, light yellowish-green leaves from the stems; and seated to the right are others occupied in stringing the leaves in small bunches on to split bamboo sticks. These are taken into the small curing barn on the right where they are hung in tiers. In front of the barn can be seen two coal furnaces which radiate their heat through metal flues running along the floor of the building. The tobacco leaves in the barn in the course of about 4 days give up their moisture and turn yellow. They are then removed from the barn and suspended overnight under a shelter to become slightly softened, and in the morning are laid in heaps and covered to keep them cool. A bullock cart may be seen taking the cured leaves away to the packing centre."

The descriptive label for the sugar diorama is as follows:—

The Village Sugar-Cane Industry

"This diorama depicts a scene in a sugar-growing district in Northern India where the crop is grown in small plots of usually less than an acre, in rotation with other plants. Away to the right and to the left can be seen crops of mature sugar cane, the modelled canes skilfully blending with the painted ones behind. The canes are being harvested by cutting each at the base, breaking off the green top, and stripping the sheath of the stem with a sickle.

"In the centre foreground the canes are being crushed between vertical iron rollers worked by bullocks. The cane juice falls through a strainer and is collected in a tin below. Near by the cane juice is being boiled in a flat metal dish and the scum removed. To the right a woman is pouring the clarified juice through a double blanket strainer into another heated dish for concentration, the thickened syrup being then transferred to another series of vessels seen in the distance for evaporating down to gur or jaggery which is the Eastern equivalent of muscovado sugar."

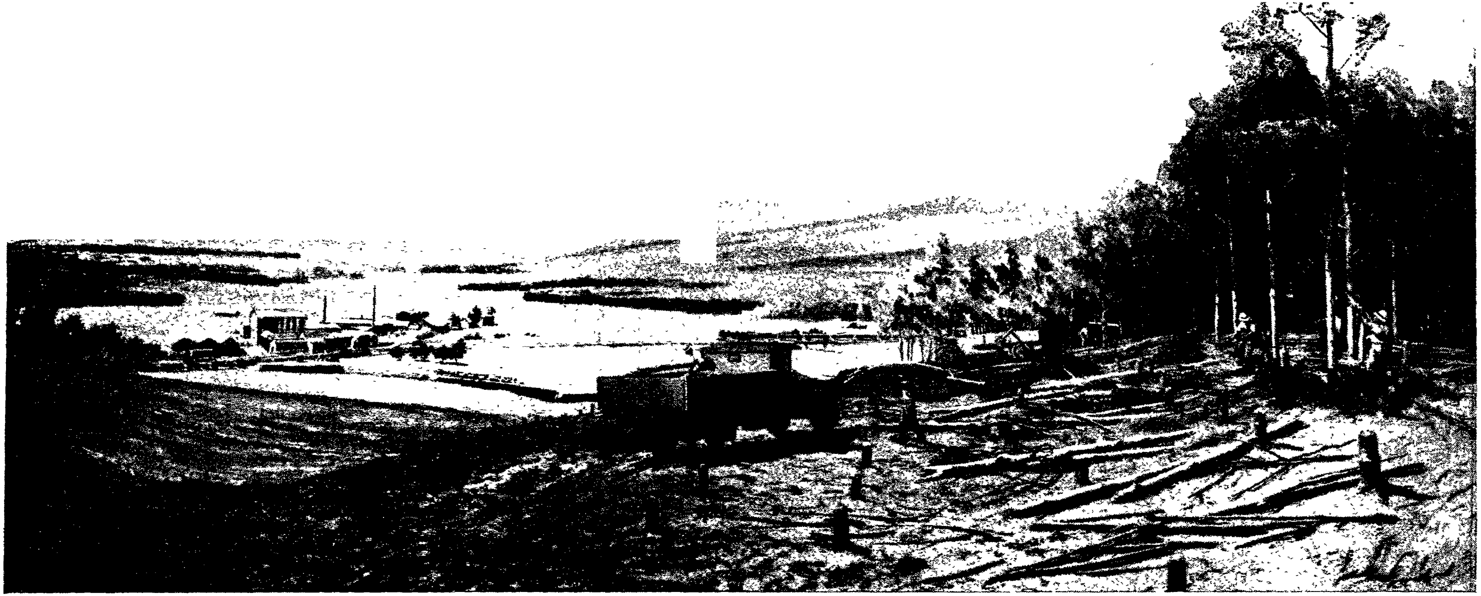
In the Ceylon Court the rubber exhibit has been rearranged in story fashion starting with the rubber seed and finishing with the various forms of raw rubber as exported, viz., crêpe, smoked sheet, latex, concentrated latex, and raw crumb rubber, and examples of typical rubber manufactures.

The Sudan Dom palm button exhibit has been made more complete by specimens showing several additional stages in the process of button manufacture. These specimens were forwarded by the Director of Economics and Trade, Khartoum.

The additions to the East Africa Court comprise a sample of Kenya crude cedar-wood oil and one of the rectified oil, received from Messrs. Wilson & Mansfield, Ltd., for display in association with cedar-wood specimens; examples of two types of *Derris elliptica* root, as grown for the manufacture of insecticides, received from the Director of Agriculture, Tanganyika; and photographs of the Lake Katwe salt industry, and of tobacco and elephant grass, all prepared from negatives kindly loaned by Mr. A. S. Thomas, of the Agricultural Department, Uganda.

To the South Africa Court have been added two new "story" exhibits. The first, kindly presented by the South African Sugar Association, traces, by means of photographs and specimens, the story of the cultivation and manufacture of sugar in Natal. The photographs show the preparation of the soil, planting, harvesting, and crushing the canes, as well as stages in the production of sugar and its by-products, the latter including "Union" motor spirit. Some excellent models in coloured wax of types of sugar canes grown in South Africa, are shown in an adjacent showcase. The caption for this display reads "The Sugar Cane—a source of Energy for Man and Motor." The second exhibit illustrates the use of chromium in the home. Here, again by means of photographs and specimens, are shown the mining and preparation of South African chromium ore for export, and the industrial uses of the metal and its compounds, including examples supplied by a number of firms to illustrate their use in tanning, dyeing, plating, and in the manufacture of wall-paper, paint, glassware, ceramics, chrome cement, and refractories.

PLATE I



A Wattle Plantation in Natal.

Reproduced from a Diorama in the Exhibition Galleries of the Imperial Institute.

To the gold exhibit have been added enlarged aerial photographs of Witwatersrand East and West presented by the Aircraft Operating Co. of Africa (Pty.), Ltd., also photographs showing stages in the preparation of gold, presented by Messrs. Dorr-Oliver Company, Ltd., and a series of photographs and specimens to illustrate gold-mining and the extraction of gold from banket ore as practised on the Witwatersrand, together with a sketch map, geological diagram and flow sheets, received from the Transvaal Chamber of Mines. The latter are being arranged in a separate showcase as an introduction to the gold utilisation exhibit.

A specimen of vermiculite received from the Minerals Adviser has also been placed on exhibition in the South African Court.

A diorama of a Natal wattle plantation, designed and constructed in the Imperial Institute studio by Mr. E. Whatley, has been installed (see Plate I). The following is the text of the descriptive label accompanying the diorama :—

The Wattle Industry

" This diorama of a scene on a wattle plantation in the Pietermaritzburg district of Natal, an important centre of this industry in South Africa, shows extensive old and new plantations of wattle clothing the hillsides in the distance, whilst on the left is a caterpillar tractor with disc-cultivator preparing a cleared area for replanting.

" In the foreground on the right workmen are seen engaged in clearing a plantation by stripping off the bark from standing trees and felling the partly stripped trees. The stripping operation is done by making one cut in the bark round the base of the standing tree and another as high up as a workman can reach with his axe, and then pulling off the bark. The tree is then felled, the branches are cut off, and the bark stripped from the remainder of the trunk.

" After removal from the tree the bark is collected, spread out in the sun to dry on special racks off the ground, or sent direct to the factory. For transport the bark is tied up into bundles and is carried by motor lorry or bullock wagon. On the road a bullock wagon is seen returning after having discharged a load of bark at the factory, whilst in the foreground a workman is tying up bundles of bark and another is loading them into a lorry. Further to the right is a lorry being loaded with pit-props, which are the stripped trunks cut to convenient lengths.

" At the factory, seen in the middle distance on the left, tannin is extracted from the bark by immersion in hot water, and the liquor so obtained is concentrated into the solid Mimosa (wattle) Extract used in the tanning trade. The train at the factory siding is loaded with wattle extract and pit-props."

To the South-west Africa Court have been added samples of Karakul wool kindly presented by Messrs. Balme and Thomas.

A model of a Gozo boat and a Dghaisa boat, and examples of locally-made homespun cotton cloths have been received from the Trade Development Officer, Valetta, through the Malta Trade Commissioner in London for display in the Malta Court.

From the Director of Agriculture, Cyprus, have been received photographs of the harvesting of "Mesowhite" cotton and a close-up of a cotton plant; these have been added to the cotton exhibit in the Cyprus Court.

Several firms have contributed to a new composite exhibit of the products of the Newfoundland sealing industry which has been placed in the Newfoundland Court. Specimens of seals of different ages are shown, together with examples of the products obtained from them. First come two baby seals in snowy white coats and then an older one showing how rapid is growth in the very early stages. For a time the cubs live on the ice floes and are plump and heavy, but when thrown on their own resources they live for a while on their reserve fat and gradually lose their fluffy white coats and become smaller in size, as other specimens in the exhibit illustrate. In their plump state before taking to the water, the white fur coats of the young seals and the blubber stored under their skin are of definite commercial value; specimens of dyed and dressed pelts, supplied by Messrs. Elwyn Ingrams, Ltd., and seal oil, are included in the exhibit. As the seals begin to lose their fat after taking to the water, their pelts change gradually from white to a dark grey and develop a shorter hair of thicker texture. A specimen in the transition stage and one with the white coat entirely lost are shown. The pelts of the older seals are valued for making seal-skin leather, and specimens of tanned skins, supplied by Messrs. T. Bevington & Sons, are shown, some in course of being split into an upper and a lower portion. The upper part is dyed and prepared for the manufacturer of fancy seal-skin goods, examples of which, such as women's handbags, dress shoes, men's wallets, belts, and similar articles, have been supplied by Messrs. Drew & Sons, Ltd., and Messrs. George Boorer, of Reigate. The "split" or under-layer of the tanned seal-skin is used chiefly for the linings of shoes and the gauntlets of gloves.

Forty-two sepia enlargements of photographs of scenes in Jamaica, presented by the Government of that Colony, are now displayed in the West Indian Court. The set, which describes a tour in miniature of some of the chief attractions of the island, begins with a view of the Palisadoes outside Kingston Harbour, and Kingston and its neighbourhood, with King's House, the residence of the Governor, groupings of palms in King Street, and the grim outlines of Fort Charles at Port Royal. In sequence are next seen Castleton and Hope Gardens, with their masses of tropical trees and plants, and Constant Spring, with its hotel, golf course and swimming pools. The views of the north side of the island show Port Antonio and Annotta Bay; scenes in Trelawny with Roaring River Falls; glimpses of life between Falmouth and Montego Bay, the former with its classic Court House, and the latter with its golf, country club and coastal bathing. The tour along the south of the island includes Spanish Town, with the Cathedral and the Rodney Memorial; Robins Bay, and its environs; studies of local types; banana and citrus plantations; and the pleasures of rafting on the Rio Cobra Canal.

Colonial Visitors.—The following is a list of officers on home leave from the Colonies who have visited the Institute during the three months November 1937 to January 1938.

NOVEMBER 1937

M. GREENWOOD, Agricultural Chemist, Gold Coast.
W. D. MACGREGOR, Conservator of Forests, Nigeria.
J. C. RAMMELL, Senior Assistant Conservator of Forests, Kenya.
C. F. M. SWYNNERTON, Director, Tsetse Research, Tanganyika Territory.
A. S. THOMAS, Assistant Botanist, Department of Agriculture, Uganda.
H. B. WATERS, Director of Agriculture, Kenya.

DECEMBER 1937

E. C. ALDERSON, Director of Publicity, Southern Rhodesia.
Captain W. W. HENDERSON, Director of Veterinary Services, Nigeria.
R. A. S. MACDONALD, Deputy-Director, Veterinary Services, Northern Rhodesia.
L. A. MARKHAM, Assistant Conservator of Forests, Tanganyika.
Lieut.-Col. Sir BERNARD REILLY, K.C.M.G., C.I.E., O.B.E., Governor, Aden.
W. M. ROBERTSON, Conservator of Forests, Sierra Leone.
Dr. W. RUSS, Geologist, Nigeria.

JANUARY 1938

L. N. H. LARTER, Government Botanist, Jamaica.
R. MACGREGOR, Veterinary Department, Malaya, Straits Settlements.
J. M. SMITH, O.B.E., Chief Veterinary Officer, Department of Agriculture and Forests, Palestine.

All Dominion and Colonial officers, as well as private residents overseas, who may be visiting London are cordially invited to come to the Institute to see our Exhibition Galleries, and to discuss scientific and technical problems in which they may be interested.

Bibliography on Insecticide Materials of Vegetable Origin.—At the first meeting of the Consultative Committee on Insecticide Materials of Vegetable Origin held on November 4, 1937, it was decided to prepare for the information of the members a quarterly Bibliography of the chief references to publications likely to be of interest to the Committee. The compilation was entrusted to the Secretary in collaboration with the Imperial Institute of Entomology and the Department of Insecticides and Fungicides of the Rothamsted Experimental Station, and the first number, covering the period October to December 1937, has now been distributed to the Committee. It was thought that such a list would be of value to workers in this field in all parts of the Empire and it has therefore been decided to publish it regularly in this BULLETIN as an addendum to the usual Bibliography. The first number will be found on pp. 123-127 of this issue.

The Cassava Industry in British Honduras.—The following statement was kindly supplied to the Imperial Institute by Mr. H. P. Smart, lately Agricultural Officer, British Honduras, before leaving that Colony to take up the post of Senior Agricultural Officer, Tanganyika.

Cassava is commonly grown in British Honduras as a foodstuff, but the largest producers are the Caribs, who occupy lands in the Stann Creek and Toledo Districts. As well as a source of food the Caribs grow cassava for the manufacture, in a small way, of starch, all of which is consumed within the Colony.

During the last ten years or so a number of attempts have been made to organise the industry with the object of developing an export trade in starch and "gaplek" (dried peeled roots). Prior to 1930 samples of starch and meal were sent to the Imperial Institute for examination. These samples were prepared by the Caribs themselves. In 1930 the Department of Agriculture undertook a small experiment in the preparation of "gaplek" and shipped a trial shipment of 540 lb. to a firm in the United Kingdom. A small quantity of native-made starch was also sent. A most encouraging report was received, but no further shipments could be undertaken owing to the high cost of ocean transport and relatively low market value of the products.

In 1933 enquiries were received from an interested party in Canada regarding the possibilities of the manufacture of cassava starch in British Honduras. As the result of these enquiries an investigation on the spot was made by the persons concerned, and in 1934 the Empire Starch Products, Ltd., was incorporated. This company took up land in the Stann Creek Valley for its factory site as well as for the growing of cassava. While essentially a manufacturing company, the promoters early realised the need for an assured minimum production of raw material in case private enterprise should not readily fulfil the needs of the factory. For many reasons the start of operations was delayed until 1936. Rapid progress has been made since then, and by the end of 1937 the company had 400 acres cleared and planted under cassava.

The native planters have been slow to take advantage of this unique opportunity of being able to grow a crop they all understand and which up to now has been in a sense a drug on the market. This shyness can be attributed in part to the fact that they have not been used to dealing with manufacturers and therefore are suspicious of the treatment they may receive. Although they have been assured of a minimum price per ton of fresh roots of $6·00 (American) delivered at the factory or $5·50 at rail side, it will probably not be until the first few sales have been made and they see actual hard cash being paid that a general planting programme will be undertaken. There is an area of approximately 200 acres of native-grown cassava in the neighbourhood of the factory which will be available for manufacture by the time the factory is erected.

The factory will be put up early this year (1938) and the company is expecting to start operating it about April. The machinery arrived in the Colony early in 1937. It is of European origin and, it is understood, includes all the latest improvements. Its capacity is estimated at approximately 2,500 tons of starch annually, but with certain alterations and additions this can be considerably increased.

The Department of Agriculture has for the last few years attempted to interest the native growers in this project. Whilst it may be thought that these attempts have not been very successful, the authorities are not discouraged as they feel that it is only a question of time before the crop is more generally grown and in larger quantities. Variety and cultural trials have been in progress on a semi-commercial scale and as a result it is now possible to supply some useful information on methods of cultivation and varieties worth growing. The most useful result, however, has been the ability of the Department to supply the greater bulk of cuttings the company required for its planting programme. Owing to the rapid rate at which the company had to plant its first fields and the fact that most of the area chosen was in high forest or old second growth forest most of the planting was done without ploughing. Judging from the growth made the rough method of preparing the land has had little retarding effect, and yields are expected to be satisfactory.

A small experimental factory was established on the Agricultural Station, Stann Creek, in 1935 in order to obtain first-hand information on costs of production and possible quality of manufactured starch. A grater and grinder were imported, the remainder of the equipment being made locally. Samples were submitted to potential buyers in Canada and the bulk of the output has been disposed of in that country. Reports received from the users state that the product is equal in all respects to that purchased from Java.

In order to encourage the industry Government has given certain concessions to Empire Starch Products, Ltd., to assist it in its initial stages. With the help of a grant from the Colonial Development Fund Government is also constructing a road from rail-side through part of the company's plantations to the factory site, a distance of about two miles.

Fibre Production in Australia.—In 1936 the Council for Scientific and Industrial Research in Australia was informed by the Government that consideration had been given to the question of introducing into the Commonwealth " fibre plants similar to sisal or *Phormium tenax* with the object ultimately of establishing an industry for the production of woolpacks, corn sacks, hessian, cordage, yarns, cellulose, and cellulose derivatives." The Council were requested to investigate the question of the best species of plants for introduction, taking into consideration such matters as climate, soil, rainfall, and economic factors. The Executive Committee of the Council commissioned Professor A. E. V. Richardson, Director of the Waite Agricultural Research Institute, and Dr. B. T. Dickson, Chief of the Council's Division of Plant Industry, to collaborate in the preparation of the desired report to the Government. The report was issued in 1937 under the title *Report on Fibre Plants and their Suitability for Commercial Production in Australia* (Canberra: Commonwealth Government Printer. Price 2*s*. 3*d*.).

After classifying the principal commercial vegetable fibres, especially those made from bark tissue (flax, hemp, sunn, ramie, jute, etc.) and those derived from the vascular systems of leaves (manila, sisal, phormium, etc.), the report proceeds to consider which of these fibres might be produced in the Commonwealth and which of them are likely to be more economically produced elsewhere. The report ends with a section entitled " Summary and Conclusions," in which the view is expressed that at the present time there is a possibility of developing an industry in Australia for flax and to a lesser extent for phormium.

It is shown that the results of Australian flax-growing efforts up to the present have been disappointing, but that if retting conditions can be improved and high-yielding strains of seed employed the position might be bettered. Preliminary trials in recognised flax areas should be carried out in co-operation with the State Departments of Agriculture, and the improved material thus obtained used as the basis for the systematic improvement of existing varieties, both for fibre and for seed purposes.

As regards phormium, the evidence available appears to show that existing prospects of the successful establishment of an industry are not promising, and that unless and until improved strains of phormium are procurable and better machinery and processing methods are available it would be preferable to confine the work on this crop to small experimental plantations, with a view to securing accurate data as to growth and development in various localities and an assessment of the amounts and quality of the fibre produced. If such experiments indicated that in any given district there would be commercial possibilities for the crop, it would be desirable to establish a plantation and milling equipment sufficiently large for the determination of the cost of production, and also to co-operate with New Zealand experts in the matter of further research.

The report also suggests that investigation should be made into the possibility of exploiting other fibre plants, particularly those indigenous to Australia. Such work would involve studies of culture, growth, and yield, processing methods and the strength of the fibres obtainable, and it is recommended that for this purpose a Vegetable Fibre Section should be established by the Council of Scientific and Industrial Research.

Production and Utilisation of Banana Fibre.—The possibility of extracting the fibre from the stems which are cut down after harvesting the fruits of the edible banana has long attracted interest, especially as this waste material is normally either burnt or dug into the ground as manure. In spite of the attention which this fibre has received, however, it is still used only locally by natives for making ropes, mats, hats, and similar articles, and, apparently it has never been extracted on any large commercial scale. The same is true also of the fibres of a number of wild species of banana which have been subjected to investigation at different times.

The fibres derived from both the cultivated and wild species of banana are similar in character to manila hemp, which is obtained from a closely related plant. There appears to be considerable variation in the quality and strength of banana fibre from different sources even when derived from the same species, and reports as to the value of the fibre are often contradictory. In some cases it has been found that the fibre yielded is of poor quality and too weak for cordage manufacture, while in others it was comparable with good quality manila hemp. This conflicting evidence may be explained partly by the variation in the fibre properties of plants at different stages of maturity. It is said that, as a rule, the strength of the fibre improves up to the time of flowering, after which there is a tendency to woodiness in the stem which affects both the quality of the fibre and the ease of extraction. It is, therefore, not possible in the case of bananas grown for fruit to extract the fibre until well after the optimum period.

Among the favourable reports which have been published may be mentioned that of R. O. Bishop in Malaya. He found that the cultivated varieties yielded a fibre superior in quality to that of the wild native species, and resembling the medium grades of "partially cleaned" commercial manila hemp. It is also recorded that in Cuba banana fibre has been successfully converted on an experimental scale into sacks for sugar, for which purpose it proved superior to jute.

Fibre of good quality, in some cases comparable with high grade manila hemp, has also been obtained from certain wild species of banana growing in East Africa, notably *Musa ensete* and *M. ulugurensis* from Tanganyika and a species from Kenya (probably *M. livingstonia*). These fibres have been examined at the Imperial Institute and reports on their quality and value appeared in this BULLETIN, Vol. III, No. 3, 1905, p. 226 (*M. ensete* and *M. ulugurensis*), and Vol. V, No. 3, 1907, p. 228 (*M. livingstonia*). *M. ensete* and *M. livingstonia* appeared the most promising, yielding fibres which, in the opinion of commercial experts, were suitable for rope-making and would find a ready sale in the London market at that time, in competition with manila hemp.

There seems little doubt that good quality fibre suitable for cordage purposes can be obtained from various species of banana. Furthermore, it has been found that such fibre can be converted into a pulp which yields a strong wrapping paper. The two factors which militate against the more extensive production of the fibre are the difficulty of extraction and the very low yield of fibre. As yet no machine has been found which will extract the fibre satisfactorily, and the use of hand labour is therefore necessary. This difficulty is further accentuated in the case of the cultivated banana owing to the late harvesting of the stems, which are therefore of a coarse and woody nature. Machines of a simple kind are used in the Philippines for the extraction of manila hemp, but much of this fibre is still prepared by hand. This is possible because the yield of fibre is so much higher than in the case of the banana. Whereas a single stem of the manila hemp plant, which weighs from about 90 to 220 lb. when freshly cut, gives from 1 to 5 lb. of dry fibre, Bishop found the yield from a stem of cultivated banana, weighing from 40 to 80 lb. in the fresh state, to be only from 1 to 4 oz. This very low fibre content would preclude the use of the stems for paper-making ; it has been estimated that 132 tons of green stems would be needed to produce 1 ton of paper.

On two estates in the Philippines power machinery is employed for decorticating manila hemp. It is understood that the machines in use are " Corona " machines like those employed for treating sisal, but with certain alterations to adapt them to the different structure of the banana stalks. In countries such as East Africa, where similar machines are already available, it might be worth while conducting experiments to determine whether they can be adapted for treating the wild banana.

The Drying of Pyrethrum.—For some years a half-acre plot of pyrethrum has been grown at the South-Eastern Agricultural College, Wye, for the purpose of making observations on the cultivation and harvesting of the crop. It has been the practice to dry the flowers produced in a hop kiln, which since 1934 has been of the type employing a forced draught of air. The draught is produced by a large fan and led through steam-heated radiator blocks before passing up to the drying floor. In carrying out the drying, some arbitary temperature had to be decided upon and 140° F. to 150° F., the maximum employed in hop drying, was taken as most suitable, although there was little evidence to show what was the optimum temperature for pyrethrum flowers. Recently a small experimental kiln, operating on the same principle, became available, and it was decided to dry comparable samples over a range of temperatures and to ascertain at what temperature the content of pyrethrins most nearly approached that of the air-dried flowers. This had not previously been done owing to the high cost of operating the larger kiln for experimental work.

The results of these tests, together with an account of the harvesting and sampling of the flowers, the technique adopted and a description of the kiln, is recorded in a report entitled " The Artificial Drying of Pyrethrum Flowers," by S. G. Jary, J. T. Martin and F. Tattersfield, recently published in the *Journal of the South-Eastern Agricultural College, Wye, Kent*, 1937, No. 40, pages 108-114. The flowers were harvested at the stage when the pyrethrin content was at a maximum, that is when the flowers were fully open, but the formation of seed had not proceeded to any appreciable extent. The picking of the flowers and the subsequent sampling were so arranged that any differences that might have existed in the pyrethrin content of the various types of flowers present on the plot harvested were eliminated. Drying tests were conducted at the following temperatures : 45° C. (113° F.), 52° C. (126° F.), 60° C.(140° F.), 68° C. (154° F.), and 75° C. (167° F.).

At the same time control experiments were carried out by air-drying comparable samples, records being kept of the daily maximum and minimum temperatures for the room in which the air-drying was done.

All samples were analysed for Pyrethrin I and Pyrethrin II by the Seil method and Pyrethrin II was also estimated by the Haller method. The Haller method showed an apparent increase in Pyrethrin II content in the kiln-dried samples over the air-dried samples for all temperatures used. Also, when the Pyrethrin II contents, as determined in the air-dried samples by the Haller and Seil methods were compared it was found that the Haller method gives somewhat lower results, whereas in the case of the kiln-dried samples the position was reversed. The authors conclude that for some reason the Haller method is unsuitable for the determination of Pyrethrin II in kiln-dried flowers, but they are unable to offer any explanation.

The experiments showed that there is a loss of pyrethrins in the sample dried at 45° C. (113° F.) for 21 hours and in those dried at 68° C. (154° F.) and 75° C. (167° F.) for 5¾ and 3½ hours respectively. There is little or no loss of pyrethrins in samples dried at temperatures of 52° C. (126° F.) and 60° C. (140° F.) for 10 and 6½ hours respectively, when comparisons are made with their air-dried controls. In other words, the quality of the flowers suffers, not only if they are subjected to high temperatures, but also if exposed to lower temperatures for a prolonged period.

Magnesium Sulphate as an Insect Poison.—A recent note in this BULLETIN, 1937, **35**, 470, quoted the results of tests carried out in America which appeared to show that magnesium sulphate gave promising results as a poison in grasshopper baits in place of arsenic compounds. A communication has now been received at the Imperial Institute from the Dominion Entomologist, Canada, stating that this conclusion cannot be supported. Magnesium sulphate bait for the control of grasshoppers was tested in British Columbia during the summer of 1937 by one of the officers of the Entomological Branch of the Department of Agriculture, and in this work the formula suggested by the original authors was followed as closely as possible. The test was made in the open under ideal baiting conditions and in an area where grasshoppers were abundant, but the material proved ineffective as a poison in grasshopper bait, and was considerably more expensive than the sodium arsenite bait already in use.

Similar negative results are reported by Roger C. Smith (*Science*, 1937, **86**, 226-8). This author states that extensive field trials of Epsom salts bait, both single and double strength, were carried out in Kansas in comparison with bait made with standard poisons, and in all cases the magnesium sulphate bait was without value for destroying grasshoppers. He also mentions that large numbers of farmers in the central west of the United States have used Epsom salts bait for grasshoppers, but, in every case so far reported, unsatisfactory results were obtained.

It has also been recorded by N. F. Howard (*Science*, 1937, **86**, 286-7) that magnesium sulphate used in solution as a spray, either at the rate of 1 lb. in 10 gallons of water or 1 lb. in 2½ gallons of water was found to be valueless for the control of the Mexican bean beetle.

It is therefore evident that, at present, magnesium sulphate cannot be recommended as an effective agent in insect control.

Chemical Weed Killers.—The use of various chemicals for the eradication of weeds is a subject which is still being investigated by many workers. The most recent summary of the available information has been published as Bulletin 18 (1937) of the National Research Council of Canada.

This gives a comprehensive critical review of the literature, mainly from the standpoints of establishing the relative toxicity of different chemical compounds and of collating the available information on proved weed killers, and also of determining what other chemicals might be considered for the purpose.

The experimental results considered are divided into three general classes according to the type of information obtained. The first of these may be termed " observational " and includes all results of a qualitative nature, such as evidence that a given chemical is toxic to certain vegetation. The second class includes field tests of a quantitative nature, where the dosage required to kill a certain plant in the field is given as pounds or gallons to be applied per unit of area. The third class can be termed " laboratory toxicity determinations " and includes the results of experiments in which the chemical was either sprayed or added to soil or water cultures grown under more or less controlled conditions.

The authors summarise the numerous published results classified under these three headings, giving wherever possible the lethal dosage required for a particular chemical on perennial or annual weeds. The chemicals considered include arsenicals, boron compounds, chlorates, halides, cyanides and related compounds, nitrates, sulphates and sulphuric acid, sulphides and miscellaneous inorganic and organic compounds which have only been tried on a small scale. The results are finally presented in a series of tables.

The article includes a very extensive bibliography.

Boron in Agriculture.—In the note under this title published in the last issue of this BULLETIN, 1937, 35, 467, reference is made to the prevention of " heart rot " of beet by the application of borax. Dr. A. W. Greenhill, Director of the Boron Agricultural Bureau, has drawn the attention of the Imperial Institute to the fact that the quantity mentioned in the note (30-40 lb. per acre) may in some cases have a serious detrimental effect either on the beet crop or the following crops of the rotation, and that the amount normally required in the case of beet is about 20 lb. Actually as much as 54 lb. per acre has been applied in experiments carried out in Silesia without depressing the sugar yield per acre, while instances are known where dressings up to 112 lb. per acre have apparently had no ill-effects. In view, however, of the possible harm of an over-dressing of borax, it seems desirable to emphasize the warning given in the penultimate paragraph of the note that in all cases care must be exercised in using the material and large quantities should only be applied on expert advice.

Fineness of Grinding of Agricultural Limestone.—It appears to be generally agreed that finely ground limestone, hydrated lime and quicklime can be regarded as equally effective for use as soil amendments when applied approximately in the ratio, limestone : hydrated lime : quicklime=4 : 3 : 2, in order to give equivalent amounts of calcium. In spite of the advantages of hydrated lime (e.g. its finely powdered condition, ease of spreading, absence of causticity and good keeping qualities), this compound is usually too expensive for agricultural use, so that practically the choice lies between finely ground limestone and quicklime. Normally the liming material is applied to a soil in relatively large quantities at fairly long intervals, often once only in a rotation lasting several years.

Quicklime has to be used in about half the quantity of limestone, and is often cheaper per unit weight of calcium. Its chief drawbacks are that it is caustic to handle, it must be slaked before spreading on the land and unless this is done with great care, unslaked lumps are often left and may remain inactive in the soil for many years. Quicklime cannot be stored for any length of time, as it absorbs moisture and carbon dioxide from the atmosphere and so swells up and bursts the bags containing it.

Ground limestone can be stored in a reasonably dry place for an indefinite period without deterioration; it is not caustic and can therefore be spread without unpleasant effects to the workmen handling it. Its chief drawback is that about twice the weight of the equivalent amount of quicklime must be transported and handled.

There appears to be no generally accepted standard of fineness for grinding agricultural limestone, and there is considerable diversity of opinion regarding the fineness which is desirable. Some authorities recommend that the limestone should all pass a sieve of 100 meshes per linear inch, while in American practice, material which passes a sieve of 10 meshes per linear inch is considered satisfactory. In this latter case, there is usually enough fine material to produce an immediate effect, while the coarser limestone is believed to become available with time. The tendency in Great Britain appears to be towards very fine grinding.

Since one of the largest items of cost of production of agricultural limestone is the expense of fine grinding, there would be considerable economy in using relatively coarse material. A series of trials have recently been carried out in Wales (" Reaction of Different Grades of Limestone with an Acid Soil," by Rice Williams, *Empire J. Expt. Agric.*, 1937, **5**, 342-8), using three types of calcium carbonate—(1) a commercial ground limestone of high purity, (2) marble which had been ground in the laboratory, and (3) pure precipitated calcium carbonate. The first two materials were separated into five grades of fineness—(1) 2 mm. to 20 mesh, (2) 20 mesh to 40 mesh, (3) 40 mesh to 60 mesh, (4) 60 mesh to 90 mesh, and (5) finer than 90 mesh. The precipitated calcium carbonate was all extremely fine. An equal quantity of each of these grades and of the precipitated carbonate was then mixed with the same weight of a fairly acid soil and the mixtures left out of doors for about two and a half years, including three winters. At the end of this period, it was shown that, under the conditions of the experiment, the reaction of the various materials with the soil was practically complete in all cases. It is therefore evident that, at any rate under the relatively cool and humid climate of Wales, the application of fairly coarsely ground limestone, e.g. that passing through a 20 mesh sieve, should be satisfactory. As mentioned above, liming is usually carried out at intervals of some years, and this period should be ample for the whole of the limestone applied to react with the soil. There should be considerable economy to the farmer in using the coarser product, while it has been suggested that the wastage by drainage water might also be less with coarse limestone than with the finer material.

The Ironsands of New Zealand.—Under this title A. W. Wylie outlines, in the *New Zealand Journal of Science and Technology*, 1937, **19**, 227-244, the results of a special study of the problems involved in the utilisation of the Taranaki ironsands. In contrast with the massive ores of Onakaka and Parapara, which offer no special difficulties to the smelter, the large deposits of ironsand on the coast at Taranaki, North Island, are markedly titaniferous, and on account of this and their fine form successful utilisation has so far been prevented.

Iron makes up nearly half of the sand; titania is present to the extent of about 10 per cent. and vanadium approximately one-third of one per cent. This readily accessible deposit lies unworked for want of a suitable process of extracting the iron, titanium, and vanadium. Much work has been done on this problem during the last sixty years, but little has been accomplished in the way of perfecting a process which can be worked economically. Electrosmelting has proved the simplest and most successful method of attack, but there is doubt as to whether it would succeed commercially owing to the high running costs. Unless some cheap process of extracting the titanium and vanadium in addition to working the sand for its iron content can be developed, there seems little hope at present of working the ironsands in competition with the more readily-treated limonitic ores at Onakaka and Parapara.

As Wylie states, even if at present it may be economic to import the major portion of the iron and steel required in New Zealand, it is desirable to have a process fully worked out which could be utilised if the necessity arose.

Black magnetic ironsand is found all along the Taranaki coast-line, but it is concentrated into rich beach and dune deposits at two localities only—at Patea in the south and at New Plymouth in the north. It is estimated that the amount of high-grade ironsand near New Plymouth does not exceed 100,000 tons, although the amount of second-grade ore capable of concentration is much larger. The more important Patea deposits have been estimated at 5,374,000 tons. In making this estimate no account was taken of sand containing more than 25 per cent. of quartz, shell fragments, etc. The quantity of beach sand available varies with the weather conditions, an important point being that it is considered likely that sand removed from the beach would be replaced by more washed in from the sea.

The ore is believed to have originated from the disintegration of neighbouring andesitic rocks and to have been concentrated by stream action, tidal currents, and wave action. The principal minerals in the sand are titaniferous magnetite, quartz, and ferromagnesian minerals such as augite, hornblende, diopside, and olivine.

The percentage of metallic iron in the first-grade ores is about 50 per cent., but this can be increased to 60 per cent. by magnetic concentration methods. Sometimes this concentration has been achieved by wave and tidal action. The content of titania in the sands varies from about 6 to 12 per cent., that of phosphorus (P) from 0·15 to 0·30 per cent., and vanadium (metal) from 0·08 to 0·20 per cent. The amount of vanadium rises with increase of iron. The sulphur content of the sand is very low. Analyses show the composition of the first-class sands to be fairly uniform.

Results published in 1917 showed that the amount of iron could be increased by magnetic separation to nearly 60 per cent. and more modern apparatus might further increase this figure. Vanadium mostly remains with the iron on magnetic separation, as also does titanium, which is then slightly increased relatively to the iron. Phosphorus is not appreciably decreased relatively to the iron on magnetic separation.

The attempts made to smelt New Zealand ironsand by charging it directly into a blast furnace with coke and limestone have met with failure ; the fine form of the sand causes choking of the furnace and prevents the blast from playing properly upon the charge. Many experiments have been made with briquetting processes without success, though the methods of E. M. Smith, J. A. Heskett, and the Esteve Steel Co. showed promise of overcoming technical difficulties. The weakness of using binding material for moulding the sand lies in the tendency of the briquettes to become friable and to disintegrate under the pressure of the furnace burden as soon as the temperature exceeds that at which they were baked. Even if technically perfected, briquetting processes would always be expensive, and the added costs of converting the fine sand to a product similar to a massive ore decrease the chances of commercial success. Other processes have also been tried.

Electrosmelting of Taranaki ironsands appears to be quite feasible from the technical viewpoint. The sand can be charged into the electric furnace along with coke and slag-forming material and either pig-iron or steel can be produced as desired ; but the working costs are high.

In conclusion, Wylie points out that one ton of the ironsand contains 4½ lb. of vanadium, worth about £2 16*s*., and 2 cwt. of titania, worth about £7 10*s*. If a suitable method of extraction could be devised and the product marketed in Australia and New Zealand, then the value of such a process is evident. In the manufacture of iron and steel both titanium and vanadium oxides pass almost entirely into the slag. Hence if these metals are to be extracted they must be extracted from the native sand or recovered from the slag. However, as a satisfactory treatment of the sand for the production of iron has yet to be devised, the problem reduces to one of obtaining these constituents from the ironsand itself, bearing in mind that it would be highly advantageous to leave the residue in a form suitable for treatment in a blast or electric furnace.

Wylie hopes to publish a report on a series of experiments on the extraction of titanium and vanadium from ironsand and also from the sand after reduction of the magnetite to metallic iron.

South Australian Rutile.—A deposit of rutile in the hundred of Para Wirra, 4 miles south-east of Williamstown, South Australia, was described in the *South Australian Mining Review*, 1934, No. 60, p. 43. A further examination of the deposit was made by the Inspector of Mines and Quarries in August 1937, and his report is contained in the latest issue of this publication (*Min. Rev. S. Aust.*, 1937, 66, 78).

The country rock in the area consists of schists and laminated quartz. The mineralisation has evidently resulted from the infiltration of acid solutions, now in the form of pegmatite dykes. Rutile is present in rich veins and patches in the quartz and in particles finely dispersed through the schists.

A shaft cut through the schistose country rock has reached a depth of 30 ft. and from it, in an easterly direction, runs a crosscut which has exposed five thread-like veins of good rutile in addition to aggregates of poorer quality mineral.

The deposit would be suitable only for open-cut mining at a limited depth. Deep mining would be difficult and dangerous on account of the wet nature of the ground and the decomposed state of the schists.

Rutile concentrates of good quality should contain at least 94 per cent. of titanium dioxide, and, as the rutile content of the rock is low, careful selection and grading of the ore is necessary before treatment. A concentrating plant consisting of a small roll crusher and a concentrating table has been erected by Industrial Metals, Ltd., who own the property. This is really in the nature of a pilot plant as its daily capacity does not exceed 2 tons of crude ore. Results obtained show that 12 tons of ore yield ½ ton of concentrates containing 80 per cent. of titanium dioxide.

In the economic working of this deposit the margin of profit is likely to be small and the Inspector of Mines stresses the importance of careful investigation into all aspects of the problem before the installation of concentrating plant on a commercial scale.

A rutile deposit in the hundred of Barossa was examined at the same time as the above. The mineral occurs here mainly as small particles finely disseminated in the country rock in old shafts which have been worked for fireclay. It is unlikely, however, that the mineral could be worked profitably except, perhaps, as a by-product of fireclay production.

The Extraction of Magnesia and Calcium Carbonate from Dolomite.—The extraction of magnesia from dolomite and high-magnesium limestones is a subject which has received considerable attention in recent years and is of special interest in the United Kingdom as other magnesium-bearing raw materials are not available. Two new methods for carrying out this extraction have recently been described, one of them having been patented by the American Zinc, Lead and Smelting Co. (Brit. Pat. 471,234 of 1937).

In the latter dolomite is calcined to break down the carbonates and is then leached with magnesium chloride solution. An exchange reaction takes place, the lime goes into solution as calcium chloride and an equivalent amount of magnesium hydroxide is precipitated. The amount of magnesium chloride added is carefully regulated so as to leave the original magnesia, with a little lime and the whole of the impurities, in the residue, which is filtered off. The resulting calcium chloride solution is treated with a slight excess of ammonium carbonate, calcium carbonate is precipitated and filtered off, leaving a solution of ammonium chloride. This is then agitated with the magnesia residue obtained from the initial extraction of the calcined dolomite. The magnesium hydroxide present reacts with ammonium chloride to form magnesium chloride equal in amount to that used in the original process, together with free ammonia. The suspension is heated to about 100° C. to expel the ammonia formed, which is combined with carbon dioxide evolved in the preliminary calcination of the dolomite to form the solution of ammonium carbonate used to precipitate calcium carbonate in the treatment of the next batch of material. After filtering off the final residue, the solution of magnesium chloride obtained is used for leaching calcined dolomite in the next cycle of operations.

The final products of the process are calcium carbonate and a residue of magnesia, containing all the insoluble impurities in the original dolomite. During the first cycle of operations magnesium chloride and ammonium carbonate are regenerated and are used for the treatment of the next batch.

A simpler process, which has been tried out only on a laboratory scale, has recently been described by C. R. Platzmann (*Cement and Lime Manuf.*, 1937, **10**, 325). Dolomite was burnt for two hours at a temperature of 2,120° F. and the residue suspended in boiling water and left to soak for 12 to 18 hours, after which the suspension was diluted with potassium bicarbonate solution. A stream of carbon dioxide was then passed into the suspension, which was vigorously stirred, for six hours and the final residue filtered off. After this treatment 87 to 90 per cent. of the magnesia was dissolved as a double potassium magnesium bicarbonate and most of the lime was present as carbonate in the residue, which also contained the impurities.

On heating the solution to 212° F. for 15 minutes the double salt was decomposed and a hydrated magnesium carbonate precipitated. This was filtered off, washed, dried and burnt to give a final product which contained over 99 per cent. of magnesia. The potassium bicarbonate used is left in solution and can be used again, while the impure calcium carbonate residue, which contains a few per cent. of magnesium carbonate can be used as a fertiliser.

Relative Value of Gypsum and Anhydrite as additions to Portland Cement.—Anhydrite, the anhydrous form of calcium sulphate, is frequently found associated with gypsum, the former material often occurring at greater depth.

A valuable contribution to the much-debated question of the relative effects of these two materials on the setting properties of cement has recently been made by P. Roller and M. Halwer, in Technical Paper No. 578, U.S. Bureau of Mines. Previous workers investigating the possibilities of the utilisation of anhydrite for retarding the setting time of cement, have obtained conflicting results, and wide differences of opinion exist as to the merits of this material for the desired purpose.

Roller and Halwer contend that the opposing conclusions arrived at by past workers are due to their failure to recognise that Portland cement exists in different states determined by the amount of water vapour adsorbed by the cement, and that this adsorbed water promotes the reaction of the added calcium sulphate with the alkali of the cement so that its effectiveness as a retarder is increased.

Throughout their work the authors kept this fundamental variable of water vapour adsorption under control. When freshly ground, all the varieties of clinker used in the work were quick setting and no amount of gypsum added subsequently would make them slow setting. When, however, the cements were conditioned with steam at a temperature above the dew point, so as to cause them to absorb water vapour, they were quite amenable to retardation.

The degree of adsorption required varied for different clinkers, and was least for those that had a high initial loss on ignition due to storage or other protracted exposure to the atmosphere. Subject to the foregoing conditions, the authors reached the following conclusions: (1) Anhydrite, used alone, has a definite but smaller effect than pure gypsum as a retarder of Portland cement, about four times as much pure anhydrite as pure gypsum of equal fineness being required to produce the same retardation. (2) With the same amount of SO_3 added in both cases, anhydrite-gypsum mixtures can be quite as effective as pure gypsum. (3) The amount of anhydrite that can be safely used in admixture with gypsum depends on the total SO_3 added, and more especially on the state of the clinker as determined by the amount of water vapour adsorbed by it. (4) The susceptibility of a clinker to retardation may be measured by the minimum amount of SO_3 that must be added as pure gypsum to retard the set. The permissible anhydrite content is then correlated with this amount of SO_3. (5) For the six clinkers investigated, with constant addition of 1·5 per cent. SO_3, anhydrite substituted for gypsum caused a small decrease in mortar strength. Tensile strengths were 5·5 per cent. lower at three days and 2·0 per cent. lower at twenty-eight days, and compressive strengths 7·5 per cent. lower at three days, decreasing to 2·0 per cent. lower at twenty-eight days. For one clinker the constant addition of 1·5 per cent. SO_3 in the form of mixtures of anhydrite (25-50) and gypsum (75-50) increased the tensile strength by an average of 6·5 per cent., and the compressive strength by an average of 3·5 per cent. This clinker differed from the others in having an unusually low alkali content.

Helium and its More Important Uses.—Helium was discovered in the solar atmosphere in 1868 by the astrophysicist Lockyer, who employed a spectroscope of special construction; it was later isolated from the mineral cleveite by Ramsay. Later workers soon established the presence of the gas in the atmosphere in the ratio of 1 part in 185,000, in radioactive substances, and in certain minerals, and these last were the sole source of helium until in 1903 a well at Dexter, Kansas, U.S.A., was found to be yielding a gas, 80 per cent. of which was nitrogen and 1·84 per cent. helium. Tests on the gases from other wells in Kansas and Texas showed helium to be a fairly common constituent.

In the early years of the century interest in the newly-found gas was purely of a scientific nature, and a large amount of experimental work was carried out with it, culminating in the liquefaction of the gas by Professor Onnes, of Leyden, in 1908. In 1914, however, Sir Richard Threlfall suggested what has so far proved to be the major, and, in fact, the only considerable use for helium. He pointed out that on account of its lightness and non-inflammability the gas might be employed to replace hydrogen in the gas envelopes of balloons and airships. The Admiralty caused experiments to be instituted in Canada for the isolation of helium from the natural gases found in the western provinces, and by a process of partial liquefaction several thousand cubic feet of gas were prepared, highly compressed, and transported in steel cylinders. Commercial plants were suggested for erection at Hamilton, Ontario, and Calgary, in Alberta, but the experimental unit tested at both localities in 1918, 1919, and 1920 clearly demonstrated that the quantity of gas available was inadequate to make any large extraction scheme feasible.

In England helium has been made from Indian monazite, but the yield was only 27 cu. ft. per ton of the mineral costing, say, £12.

On the entry of the United States into the War, in 1917, the U.S. Bureau of Mines established liquefaction plants on the Petrolia field, Clay County, Texas, and at Fort Worth, Texas, from which approximately 200,000 cu. ft. of helium were obtained in trials, of which 147,000 cu. ft. reached New Orleans for shipment to Europe for use in observation balloons, when hostilities ended. These plants were subsequently scrapped and a large-scale unit known as the U.S. Helium Production Plant was constructed at Fort Worth, which closed down in 1929 owing to the exhaustion of the gas field. A second plant was then erected at Amarillo in the Panhandle field, Texas, 50,000 acres of the Cliffside gas area being reserved for the Government. The capacity of the plant, which is in two units, exceeds 24 million cu. ft. of helium annually. Helium is transported from the plant to Army and Navy aviation stations in tank cars carrying the gas at a pressure of from 2,000 to 2,250 lb. per sq. in. The cost of production has varied between $7 and $12 per 1,000 cu. ft.

As has been mentioned, helium finds an outlet principally as a lifting gas for lighter-than-air craft. Hydrogen, which is approximately 8 per cent. lighter than helium, has been used extensively in both Germany and the United Kingdom for this purpose, but a series of disasters which, culminating in that to the British airship R.101 at Beauvais, resulted in the abandonment of airship construction in this country, and more recently, the loss of the Hindenburg at Lakehurst, has again forcibly indicated the risk attendant on the employment of such a highly inflammable lifting medium. Germany has now apparently decided to employ helium in the latest airship and for this purpose a consignment of the gas in steel drums is being prepared for shipment at Houston, Texas.

Among the less important uses may be mentioned the use of the gas in deep caisson work and diving operations, to replace the nitrogen in the air. When men are working in air under abnormal pressures, nitrogen is absorbed by the blood, and should normal atmospheric conditions be resumed too hurriedly the nitrogen is released as bubbles and produces intense pain known as the "bends." The use of a helium-oxygen mixture obviates this trouble since helium is not absorbed by the blood. As a result, by supplying a diver with an artificial atmosphere of helium and oxygen, a record descent to a depth of 420 ft., was made in Lake Michigan last December, the previous record being 360 ft. This trial is one in preparation for an attempt to salvage the Cunard liner *Lusitania* lying off the Old Head of Kinsale in 312 ft. of water.

Helium is also employed in the discharge tube type of illumination so commonly resorted to for advertising signs, and this constitutes the only commercial use for the gas in the United Kingdom. In this country the entire bulk of the gas is obtained as a by-product from the atmospheric liquefaction method of preparing oxygen. Two forms of gas are marketed, the absolutely pure variety, and a mixture of helium with small quantities of nitrogen and neon, etc. Normally, the discharge tubes are of two sizes, one 11 to 12 mm. diameter and the other 40 mm. diameter, the smaller tube having a current discharge of 30 milliampères and the larger of 50 milliampères. The impure helium is used to clear out residual air from the tubes before they are charged with neon, pure helium, or other gases. The pure gas, at pressures of 3 to 4 mm. of mercury, gives an ivory white colour in plain glass tubes or a golden colour in tinted tubes.

The gas is sold in glass bulbs of 200 cc. capacity, and in glass cylinders of 1¼ and also 2½ litres, the retail price for the impure gas being 27*s.* a litre, and for the pure gas 33*s.* a litre.

The production of rare atmospheric gases in this country has been estimated at 10,000 litres a year, of which about 50 per cent. is neon and 30 per cent. helium, the rest being principally argon.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

Beverages

Cacao

Gold Coast.—In a report on investigations conducted by the Department of Agriculture during the period July-December 1937, reference is made to some experiments which have been carried out on simple methods of fermenting small lots of cacao. It is stated that successful results have been obtained by placing the unfermented beans in a small perforated box (a whisky case proved suitable) which had a grid fixed inside it. This box was surrounded by wet grass and fitted into an old cement barrel. Fermentation is assisted by the heat evolved from the fermenting grass, and the cacao can be turned frequently without loss of heat by simply rolling the barrel. The method has proved suitable for weights of about 20 lb. of cacao, and is easy for farmers to copy. For larger quantities of 100-150 lb. of cacao, perforated cement barrels, fitted with a grid inside, have also proved suitable, the beans being easily turned by rolling the barrel as before. The resulting product has shown a good even fermentation.

SUGAR

Cane

Leeward Islands. *Antigua.*—A report on the sugar cane experiments reaped in 1936 has been furnished by Mr. F. H. S. Warneford, Agricultural Superintendent, Antigua. The experiments form part of a comprehensive series conducted by the Department and by the Agronomist of the Gunthorpes Estates, under the direction of Mr. P. E. Turner, Adviser in Sugar Cane Experiments to the Commissioner of Agriculture, and under the auspices of the Sugar Cane Investigation Committee of Antigua. They comprise small-scale experiments with different manures conducted at the Greencastle Experiment Station, and varietal manurial and cultural experiments with plant canes and ratoons carried out in the field at estates in different localities. The detailed results of the manurial experiments are given in a paper by Turner, Warneford, and Charter published in *Tropical Agriculture* (Trinidad), 1937, **14**, 150-155, 179-188, and the results of the other experiments are to be published in later papers. The following summary relating to the varietal, manurial, and cultural field experiments is taken from Mr. Warneford's report.

Varietal Experiments.—Ba.11569 has done well both as a plant cane and as a ratoon at Thibous and at Collins. It has done well as a plant cane at Sandersons, despite difficulty of establishment and at Paynters. At the latter station it ratooned badly, but so did most other varieties.

B.2935 has done well both as a plant and as a first ratoon at Thibous and at Collins. It did well as a plant cane at Paynters, but failed as a ratoon. In the 1934-36 experiments it has done well as a plant cane on lagoon clay at Parham New Work, but has done only moderately well on the alluvial soil at Jolly Hill.

B.147 (B.4507) has done well as a ratoon at Collins, but has not done very well on the same soil type at Thibous, possibly owing to poor establishment during the plant cane crop. As a plant cane it did not do well at either station, probably owing to late planting. It has also given poor results as a plant cane on alluvial soil at Jolly Hill and on lagoon clay at Parham New Work even when planted early.

B.H.10.12 has done well at Jolly Hill as a plant cane and moderately well at Sandersons.

B.726 has done well at Sandersons as a plant cane, but rather poorly at Jolly Hill, and it has failed at Paynters.

P.O.J.2878 has done well as a plant cane at Jolly Hill and has ratooned relatively well on the non-fertile tuff at Paynters.

The general position as regards the varieties may be summarised as follows.

Ba.11569 both as a plant cane and as a ratoon does well on most types of soil in Antigua, and of the established varieties is the nearest approach to a general purpose cane. It is a quick growing variety and stands drought well. Its juice qualities are moderately good, but at times its germination is indifferent.

B.2935 is a possible competitor of Ba.11569 on the well-drained calcareous marl soils. There are indications that while it will do well as a plant cane on heavier soils, it is intolerant of poor drainage and will fail as a ratoon on such soils. Its juice qualities are only moderately good, but it is usually a ready germinator.

B.147 (B.4507) has long had a reputation as a good cane for the lighter calcareous marl soils. It ratoons well and is drought resistant ; it is intolerant of poorly drained soils and must be established early. The germination of this variety is excellent if the cuttings are soaked for 48 hours in saturated lime-water ; otherwise germination may be indifferent unless soil moisture conditions are especially favourable.

B.H.10.12 does well on the alluvial soils and on the calcareous marls, calcareous clay tuffs, and the more fertile clay soils at Ottos under conditions of fair rainfall. It is intolerant of poor drainage and dry situations, and for the latter reason it is not generally suited to the calcareous marls of the east and north-east districts.

B.726 is a possible competitor with B.H.10.12 on some of the soil types suited to the latter. It is well suited to the alluvial soils of the Bendals area and although it has not done well at Jolly Hill in the experiment reaped in 1936 it has done well there in the case of experiments reaped in previous years.

P.O.J.2878 appears to be well suited to the alluvial soils of the Bendals and Jolly Hill areas. This variety has done well in most parts of Antigua in years of exceptionally high and well distributed rainfall, but in normal years it is suited only to the wetter districts or to soils which are naturally wet owing to their topographical situation. It is a very easy cane to establish and makes rapid early growth, but requires a plentiful supply of moisture throughout the growing period to give good yields. The juice contains a fairly high percentage of sucrose, but possesses certain undesirable qualities which render this cane poor from the factory point of view.

S.C.12.4 is not well suited to most soils in Antigua.

B.6308 is definitely inferior both from field and factory points of view.

Manurial and Cultural Experiments.—Significant and considerable gains in yield have followed the application of pen manure to plant canes at Pares and Cochranes. At Gaynors the pen manure applied to the plant cane crop has exerted significant residual effects on the first ratoons.

About 12 to 15 tons pen manure per acre appears to be the optimum application for producing economic gains, the rate of increase in yield with heavier applications falling off rapidly.[1]

At Ottos the increased yield due to pen manure, although significant, is very small. The manure used in this experiment was very dry and of rather poor quality ; it was applied late—six months after planting.

Late applications of filter press mud and of pen manure at Thibous failed to give increased yields. The residual effects of applications made to the plant cane crop at Yeamans have been significant, especially in the case of pen manure and of the heavier applications of filter-press mud.

On the alluvial soil at Greencastle the increased yields following the application of sulphate of ammonia alone to plant canes which received a basal dressing of 10 tons pen manure per acre were small and were not significant.

In the 1934-36 experiments conducted by this Department no significant increases in yield have resulted from the application of sulphate of ammonia alone to plant cane on soils receiving no pen manure, except in the case of one experiment where the application was made in the presence of a partly decayed trash mulch.

No significant gains in yield have followed late applications of complete inorganic fertiliser.[2] The lack of response may have been due to the lateness of the applications. Support is given to this view by the very small response to late applications of pen manure at Ottos and the lack of response to late applications of pen manure and of filter-press mud at Thibous ; the response to early applications of complete inorganics in a small-scale experiment at Greencastle also supports this view.

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[1] It is important to note that applications of pen manure, even when made early are not invariably followed by economic gains in yield. In one experiment C. F. Charter has found that 20 tons good pen manure gave only 1·35 tons per acre gain.

At Gaynors the pen manure was applied nearly six months after planting, but germination and early growth were slower than at Ottos.

[2] Significant gains from a complete inorganic fertiliser applied early have been obtained at Vernons and at Delaps—experiments conducted by C. F. Charter.

Small but significant gains in yield resulted from the application of sulphate of ammonia to ratoon canes on a highly calcareous soil at Collins. This result is similar to those obtained on calcareous marls at Fitches Creek and the Diamond in 1935.

Small but significant residual effects from sulphate of ammonia alone applied to the preceding crop were obtained at Betty's Hope and La Roches. The total gains from nitrogen alone were large. At the latter station nitrate of soda also showed a slight residual effect. There was no residual gain from sulphate of ammonia at Gaynors and at Parham Lodge the results of the two crops—plant cane 1935 and first ratoon 1936 indicate a small but significant loss resulting from applications of nitrogenous fertilisers. This is characteristic of highly calcareous soils.

The question of the response of Antigua soils to various mixtures of inorganic manures, including complete inorganics, is now under more thorough investigation in a series of experiments which were laid down in 1935. These experiments will enable a more critical direct comparison to be made between the value of organic and inorganic manures than has been possible previously.

As was the case in 1935, no increase in yield has been obtained in Antigua from the breaking of banks. In the 1936 experiments, breaking was carried out in two stages and was begun within two months of planting. At Willis Freemans a marked decrease in the number of tillers was observed to follow the preliminary breaking and it is obvious that "lateness" has not been responsible for the failure of breaking to cause increases. It seems probable that the deep furrows customary in Antigua are unsuited for this cultural operation owing to the burying of the plants when the large volume of earth contained in the high banks is returned to the furrows, and that normal furrows would be more satisfactory. The gains to be derived from the operation if carried out successfully have been described in the *Report on the Agricultural Department, Antigua*, 1935, p. 33.

Cross-holing has again proved inferior to planting in the open furrows, although the difference in yields is not significant in the case of either experiment. At Gaynors conditions were such as are generally considered to be favourable to cross-holing. One argument in favour of cross-holing is that the cross-hole bar provides a convenient means of applying manure to the plant cane crop. It would appear desirable to compare pen manure applied in this way with an equal application ploughed into the furrow.

At Blackmans planting at 2 ft. in the row has given a small but significant gain in yield as compared with planting distances of 3 ft. and 4 ft. It is unlikely that such a gain would be economic in view of the increased cost of plants and planting at the 2 ft. spacing. At Thibous the ratoon yields confirm the results obtained as plant cane that no benefits result from planting at a smaller distance in the row than 4 ft.

October and November planting of B.H.10.12 gave significantly higher yields than September, December or February planting. The best germination was obtained in September, and the plots established during that month stood the dry months of 1935 sufficiently well to outyield the December and February plots. Earlier planting than is generally practised appears desirable.

At Jolly Hill the early plot (October) of B.147 (B.4507) outyielded the late (December) plot by 7·12 tons per acre. At Parham New Work the " late " plot germinated more readily than the " early " plot as a result of soaking in lime-water and was established before the latter. It outyielded the " early " but later established plot by 2 tons per acre.[1]

Windward Islands. *St. Vincent.*—According to the report of the Acting Agricultural Superintendent for the six months January to June 1937, a scheme for the reorganisation of the sugar-cane syrup industry in St. Vincent was embarked upon in 1935 with the aid of a grant from the Colonial Development Fund, and as a first measure a Crop Specialist, Mr. C. C. Seale, was appointed to introduce measures for effecting an improvement in the quality of the syrup manufactured in the island.

The work done by the Crop Specialist has been directed mainly towards standardising the methods of manufacture, improving the clarification of the juice and the adoption of an efficient and reliable inverting agent. A considerable degree of success has been achieved in spite of unremunerative prices, and Mr. J. G. Davies, Sugar Technologist of the Imperial College of Tropical Agriculture, reporting on the quality of the syrup manufactured within the past six months stated that St. Vincent syrup was equal in quality to the Barbados " Bema" syrup, the accepted standard syrup of the Canadian and United States markets.

There is still considerable variation, chiefly in colour, in the products of the various factories, but it is hoped to overcome this by blending the various syrups to form a uniform St. Vincent syrup.

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[1] Neither soil type was well suited to B.147. On a soil type well suited to this variety C. F. Charter obtained increased yields from September and October plantings as compared with later plantings.

ROOT CROPS

Arrowroot

Windward Islands. *St. Vincent.*—According to the report of the Acting Agricultural Superintendent for the six months January to June 1937, experiments on the manurial requirements of the arrowroot crop have been in progress in St. Vincent since 1933 and have yielded much information. The results of these experiments all indicate that deficiency of nitrogen in the soil is by far the most important factor limiting yield of rhizomes. Applications of 3 cwts. of sulphate of ammonia frequently resulted in an increase in yield of 50 per cent. or more. The responses to potash and phosphate have been very variable; in some cases slight increases have been recorded, but in other cases these manures have actually exerted a depressing effect on yield.

Further experiments of the factorial type are being carried out to study the interaction of potash and phosphate with nitrogen. It is thought that if the nitrogen deficiency is satisfied quite large increases in yield may be obtained from the addition of potash, especially as analyses indicate that the content of available potash is low in St. Vincent soils.

Cocoyams

Gold Coast.—In the report on investigations conducted by the Department of Agriculture during the period July-December 1937, the following statement is made relating to cocoyam root rot.

Cultural work has been started in the attempt to reisolate organisms associated with diseased roots. Cultures have been set up of the tissues of dying roots from :—

(*a*) Healthy plants from an area where the disease has never been reported ;

(*b*) Healthy plants from an area where the disease has been in evidence in the early part of this year ; and

(*c*) Diseased plants.

In this way an attempt is being made to discover whether fungi associated with diseased plants (fungi in " sick soil ") are normally associated with the dying roots of healthy plants. Numerous fungi, which are apparently saprophytes, have been isolated, and a species of *Rhizoctonia* has been observed in association with dying roots of plants from both diseased and healthy areas. *Rhizoctonia* has never appeared in the cultures however. Recently a fungus with mycelium like that of a *Pythium* has been isolated from a diseased root in the early stages of the disease. No spores have yet been produced, but there is little doubt that it is a *Pythium.* Various root studies in special glass-sided boxes are being set in hand.

FRUITS

Citrus

Leeward Islands. *Montserrat.*—According to a report on the work carried out at the Experimental Station, Montserrat, for the half-year January-June 1937, nursery work was continued on the propagation of material for planting out a large experimental plot, designed to collect information on root stocks for the West Indian lime.

The stocks involved in this experiment are the sour orange and the rough lemon (both from seed imported from Trinidad) and also a local type of " Silver Sweet " or Seville orange.

Owing to the very dry conditions at the time, when stocks were fit for budding, bud union proved very difficult and the percentage of successes was low. With the advent of more favourable weather at the latter part of this period rebudding was undertaken and better results were obtained.

VEGETABLES

Onions

Leeward Islands. *Montserrat.*—According to a report on the work carried out at the Experimental Station, Montserrat, for the half-year January-June 1937, a small plot was planted in October 1936 with onion seedlings of the Red Bombay variety which has been perpetuated for some years from seed raised locally.

Normally the production of seed depends upon a process involving two generations. In the first season only a negligible amount of seed is produced, the crop consisting mainly of bulbs. Bulbs are then selected for planting in the following season when flowering is more profuse and there is found to result a greater proportion of seed setting.

Exceptional weather conditions this year, with heavy rains in January followed by an unusual and prolonged drought, favoured the production of seed in the seedling plots. A considerable amount of one-generation seed has therefore been collected this year for further perpetuation and multiplication.

MINERAL RESOURCES

GOLD COAST

The Imperial Institute has received the following statement from the Director regarding the work carried out by the Gold Coast Geological Survey during the six months ended December 31, 1937.

The 1 in. geological map of the Tarkwa goldfield and surrounding country was completed, and the mapping of a more restricted area in the neighbourhood of the working mines, partly on a scale of 1 : 10,000 and partly on a scale of 1 : 25,000 has been started.

At the request of one gold-mining company a detailed geological survey was made of the concession and the underground workings of their mine. Examinations of the workings of six other gold mines and prospects were also carried out at the request of mining companies.

Nsuta Manganese Ore Deposits.—The detailed geological mapping of the Nsuta manganese ore deposits and the surrounding country was almost completed at the end of 1937. The additional work done during the half-year proves that the ores are confined to a zone of grey, purple, and black phyllites intercalated in lavas and tuffs near the top of the Upper Birrimian, and that the occurrence of manganese ores at varying distances across the strike of the country results from repetition of the manganese beds by folding. The presence of ore-bodies at scattered intervals within the manganese beds is due principally to the existence of lenses of manganese ore bedded in the original sediments.

An alleged discovery of manganese ore near Huni Valley was investigated and a report submitted to Government.

Water Supply.—The Water Supply Section has begun the construction of dams, ponds, and wells in Western Dagomba, Northern Territories. Progress has been slow owing to the delay in filling appointments and in obtaining materials from England.

Publications.—*Bulletin No.* 9, " A Bibliography of Gold Coast Geology, Mining, and Archæology," was published, and *Bulletin No.* 10, " The Geology of the Tarkwa Goldfield and adjacent Country," was sent to the printers.

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The publications issued by the Governments of the Colonies and Protectorates can be obtained from or through the Crown Agents for the Colonies, 4 Millbank, Westminster, S.W.1. Applications for Dominion and Indian Government publications may be made to the Offices of the High Commissioners or Agents-General in London.

PLANT AND ANIMAL PRODUCTS

AGRICULTURE

General

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Report on the Operations of the Department of Agriculture, Burma, for the year ended March 31, 1937. Pp. 259, 9¾ × 6½. (Rangoon : Superintendent, Government Printing and Stationery, 1937.) Price Rs. 3 As. 8.

Report of the Trade Commissioner for Ceylon in London for the year ending March 27th, 1937. Pp. 39, 9¾ × 6. (Colombo : Government Record Office, 1937.) Price 75 cents.

Annual General Report for 1936 on the Economic, Social, and General Conditions of Ceylon. Pp. 163, 9¾ × 6. (Colombo : Government Record Office, 1937.) Price Rs. 2.

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Report on the Work of the Indian Trade Commissioner during 1936-1937. Pp. 93, 9½ × 6. (London: Office of the High Commissioner for India, 1937.) Price 4*s.* 8*d.*

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IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 1

(October to December, 1937)

Prepared in collaboration with the Imperial Institute of Entomology and the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

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Annual Report of the Department of Agriculture, Tanganyika, 1936. Notes on derris on page 18.

Annual Report on the Department of Agriculture, Malaya, for the year 1936. Notes on derris on pages 22, 23, 46, 48, and 56.

Reports of the Field Branch, Department of Agriculture, S.S. and F.M.S., for the year 1936. Notes on derris on pages 12, 13, 71, and 106.

A New Method of Harvesting, Drying, and Sampling Derris Root. By C. D. V. Georgi. *Malay. Agric. J.*, 1937, **25**, No. 10, 425-429.

Derriswortel als Handelsproduct. (Derris root as a trade product.) By W. Spoon. *Ber. No.* 117, *Hand. Mus. Kolon. Inst. Amst.* Pp. 3.

Voorwaarden door den Gebruiker aan Derrispoeder en Derrisstuifmengsel te stellen. (The properties required in derris powder and derris dust mixture.) By W. Spoon. *Tijdschr. PlZiekt.*, 1937, **43**, No. 8, 189-192. (*R.A.E.*, 1937, **25**, A, Pt. 11, 735.)

Pyrethrum and Derris Dust. By A. Kelsall and H. T. Stulz. *Rep. Entom. Soc. Ont.*, 1936, 20-29. (*R.A.E.*, 1937, **25**, A, Pt. 12, 775.)

Stickers for Derris on Cabbage and Beans. By R. A. Fulton. *Chem. Abstr.*, 1937, **31**, No. 19, 7184. Short abstracts of *Bull. E.T.* 107, *Bur. Ent., U.S. Dep. Agric.*

European Corn Borer Investigations. Experiments with Insecticides on Early Sweet Corn. By C. H. Batchelder, D. D. Questel and N. Turner. *Bull. No.* 395, *Conn. Agric. Exp. Sta.*, 274-285. Includes a report of tests carried out with nicotine tannate and derris. (*R.A.E.*, 1937, **25**, A, Pt. 12, 769.)

Spraying for Plum Sawfly : with Notes on Red Spider and Thrips. By F. R. Petherbridge and I. Thomas. *J. Minist. Agric.*, 1937, **44**, No. 9, 858-865. Experiments to test the value of derris as compared with quassia.

Lonchocarpus

El Cube y otros Barbascos en el Perú. (Cube and other barbasco plants in Peru.) By J. E. Wille, J. A. Ocampo, A. Weberbauer, and

D. Schofield. *Bol. No.* 11, *Estac. Exp. Agric. Minist. Fom. Perú.* Pp. 117. (*R.A.E.*, 1937, **25**, A, Pt. 12, 760; B, Pt. 12, 284.)

Cube Exports—Peru. *World Trade Notes, U.S. Dep. Comm.*, 1937, **11**, No. 39, 635. Figures given for 1935, 1936, and first five months of 1937.

Rotenone-Bearing Root Exports—Brazil. *World Trade Notes, U.S. Dep. Comm.*, 1937, **11**, No. 42, 684. Figures for exports of timbo root and powder during first half of 1937.

Experiments to Control Hairy Chinch Bug infesting Turf on Long Island. By G. F. MacLeod and K. E. Maxwell. *J. Econ. Ent.*, 1937, **30**, No. 3, 432-437. The use of cube and tobacco dusts and nicotine sprays. (*R.A.E.*, 1937, **25**, A, Pt. 11, 688.)

Others

The Insecticidal Properties of Some East African Plants. II. *Mundulea suberosa* Benth. III. *Mundulea suberosa* Benth.—Chemical constituents. IV. *Mundulea suberosa* Benth.—Variability of samples. By R. R. Le G. Worsley. *Ann. Appl. Biol.*, 1936, **23**, No. 2, 311-328; 1937, **24**, No. 3, 651-658, 659-664. (*R.A.E.*, 1938, **26**, A, Pt. 1, 34.)

Chemical and Insecticidal Tests of Samples of *Tephrosia toxicaria.* By H. A. Jones and W. N. Sullivan. *J. Econ. Ent.*, 1937, **30**, No. 4, 679-680. (*R.A.E.*, 1938, **26**, A, Pt. 1, 29.)

PYRETHRIN-CONTAINING MATERIALS

Annual Report of the Department of Agriculture, Kenya, 1936, Volumes 1 and 2. Pyrethrum Experiments: Notes on breeding, spacing trials, manuring, and drying in Vol. 1, pages 37-38, and notes on drying and pyrethrin content in Vol. 2, pages 34-35.

Agricultural Census, Kenya, February, 1936. Table including area under pyrethrum in each district faces page 11.

Annual Report of the Department of Agriculture, Tanganyika, 1936. Notes on pyrethrum on pages 18 and 43.

L'Agriculture du Congo Belge en 1936. *Bull. Agric. Congo Belge*, 1937, **28**, No. 2, 271, 277. Includes brief account of experiments which are being conducted with pyrethrum in the province of Costersmanville, Belgian Congo.

The Artificial Drying of Pyrethrum Flowers. By S. G. Jary, J. T. Martin and F. Tattersfield. *J. S.-E. Agric. Coll.*, 1937, No. 40, 108-114. (*R.A.E.*, 1937, **25**, A, Pt. 11, 706.)

Pyrethrum. Short Crop and Poorest Quality in History mark Receipt of 1937 Crop Flowers. *Soap*, 1937, **13**, No. 12, 107-109.

Pyrethrum Production Registers Gain—Bulgaria. *World Trade Notes, U.S. Dep. Comm.*, 1937, **11**, No. 42, 683.

Pyrethrum Exports—Yugoslavia. *World Trade Notes, U.S. Dep. Comm.*, 1937, **11**, No. 41, 669. Figures given for total exports of pyrethrum flowers and powder for 1936 and first half of 1937.

Pyrethrum Prices. *E. Afr. Agric. J.*, 1937, **3**, No. 2, 95. Graph showing prices during 1935, 1936, and 1937 of Kenya and Japanese pyrethrum.

Constituents of Pyrethrum Flowers. VII. Behaviour of the pyrethrins on hydrogenation. VIII. Presence of a new ester of pyrethrolone. By H. L. Haller and F. B. La Forge. *Brit. Chem. Abstr.*, 1937, A, II, Dec., 511. Abstract of paper in *J. Org. Chem.*, 1937, **2**, 49-55, 56-61.

Constituents of Pyrethrum Flowers. IX. Optical rotation of pyrethrolone and the partial synthesis of pyrethrins. By H. L. Haller and F. B. La Forge. *Brit. Chem. Abstr.*, 1937, A, II, Nov., 462. Abstract of paper in *J. Amer. Chem. Soc.*, 1937, **59**, 1678-1681.

Pyrethrum and Derris Dust. By A. Kelsall and H. T. Stultz. *Rep. Entom. Soc. Ont.*, 1936, 20-29. (*R.A.E.*, 1937, **25**, A, Pt. 12, 775.)

Blooming of Potatoes as influenced by Pyrethrum Dust. By E. O. Mader and E. C. Udey. *Exp. Sta. Rec.*, 1937, **77**, No. 5, 599. Brief abstract of article in *Phytopathology*, 1937, **27**, No. 1, 112, 113.

On New Insecticides against Insect Pests of Wool. (In Japanese.) By S. Takei and K. Tada. *Bochu Kagaku*, 1937, No. 1, 3-8. The use of pyrethrum and rotenone. (*R.A.E.*, 1937, **25**, A, Pt. 11, 675.)

Les Insectes dans les Aéronefs. By C. B. Symes. *Bull. Off. Int. Hyg. Publ.*, 1937, **29**, No. 6, 1150-1157. Contains an account of a non-inflammable pyrethrum spray for the treatment of the interiors of aeroplanes against mosquitoes. (*R.A.E.*, 1937, **25**, B, Pt. 11, 253.)

OTHER MATERIALS OF VEGETABLE ORIGIN

Sur un Procédé Nouveau de Protection des Cultures contre les Acridiens. By M. Volkonsky. *C.R. Soc. Biol.*, 1937, **125**, No. 18, 417-418. Protection of plants against locusts by extracts of the leaves of *Melia azedarach.* (*R.A.E.*, 1937, **25**, A, Pt. 11, 670.)

Sur l'Action Insecticide de la Feuille d'Asebo (*Pieris japonica* D. Don). By J. Motte. *Ann. Mus. Colon. Marseille*, 1937, **25**, Sér. 5, Vol. 5, Fasc. 1, 22-24.

Spraying for Plum Sawfly: with Notes on Red Spider and Thrips. By F. R. Petherbridge and I. Thomas. *J. Minist. Agric.*, 1937, **44**, No. 9, 858-865. Experiments to test the value of derris as compared with quassia.

L'Infuso di Legno Quassio nella Lotta contro le *Hoplocampa* delle Susino. (Quassia chips infusion in work against plum sawflies.) By A. Ellis. *Note Fruttic.*, 1937, **15**, No. 10, 160-163. (*R.A.E.*, 1938, **26**, A, Pt. 1, 5.)

A New Fly Repellent and a Blowfly Dressing. Preliminary Report. By H. C. Monnig. *Onderstepoort J.*, 1936, **7**, No. 2, 419-430. An account of the oil from the leaves, flowers, and seeds of *Tagetes minima*, a weed common in South Africa. (*R.A.E.*, 1937, **25**, B, Pt. 11, 245.)

NOTE.—The reference in brackets—*R.A.E.*, etc.—which appears after certain items of the bibliography, indicates the part and page of the *Review of Applied Entomology* in which an abstract of the publication mentioned can be found.

NOTICES OF RECENT LITERATURE

Books for review should be addressed to " The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

CHISHOLM'S HANDBOOK OF COMMERCIAL GEOGRAPHY. Entirely rewritten by L. Dudley Stamp, D.Sc., B.A. Pp. xi + 884, 8½ × 5½. (London: Longmans, Green & Co., Ltd., 1937.) Price 25*s*.

In an editorial note to the edition of Chisholm's *Handbook of Commercial Geography* issued in 1932, Dr. Stamp mentioned that several years must elapse before another edition would be possible, and in a notice of the book in this BULLETIN (1932, **30**, 383) it was suggested that for such an eventual new edition the book should be reset throughout and numerous alterations made in order to bring it up to date. The present volume is not offered as a mere new edition of the old work, but essentially as a new book, for which Dr. Stamp takes responsibility, although he states that he has " endeavoured to retain as much as possible of the old Chisholm." It has accordingly been possible to avoid the mixture of types which characterised the later editions of the previous work, and the general appearance and style of the book are very attractive.

Some lack of balance is still apparent in the relative amounts of space devoted to certain countries, and various errors on technical subjects have been retained: e.g. the reference to the common nettle as an important fibre-yielding plant (p. 148); the apparent implication that all piassava is obtained from *Attalea funifera* (p. 204); the statements that palm kernel oil is a substitute for olive oil (p. 212) and that tung oil is obtained from *Aleurites cordata* (p. 614); the use of the term " henequen " for East African sisal (p. 689); and the questionable description of phormium fibre as " a kind of flax " (p. 691). These and other similar inaccuracies can be corrected by reference to technical experts before the issue of the next edition, which, in view of the present unstable state of world economics and industry, will undoubtedly be needed on general grounds in a few years time.

As an exposition of commercial conditions throughout the world and the principal industries of the more important countries, the book is not only readable but eminently instructive, and should prove no less popular than the original work. It is, however, suggested that the next edition should contain a larger number of maps; not for enabling the student to dispense with an atlas, but because the supply of maps in the present volume is very inadequate for illustrating the text itself.

AGRICULTURAL MARKETING IN NORTHERN INDIA. By S. A. Hussain, B.Com., Ph.D. (Econ.). Pp. 342, 8½ × 5½. (London: George Allen & Unwin, Ltd., 1937.) Price 15*s*.

This volume, to which a Foreword is contributed by Sir Harry Lindsay, Director of the Imperial Institute, and which consists of a thesis approved for the Degree of Doctor of Philosophy in the University of London, is a work of no little importance and interest. The author has become impressed by the backward and unorganised state of Indian agriculture, whilst recognising, as Sir Harry Lindsay points out, the valuable lead which has been given towards its improvement by the Royal Commission on Agriculture and by the Imperial Council of Agricultural Research. In order to study conditions on the spot he made an extensive tour through various provinces of India and obtained information from representatives of the different interests concerned, and the result is the present clearly written treatise, which should be read by all concerned with the welfare of rural India and the measures employed to advance its progress.

Dealing principally with the staple agricultural commodities of Northern India, viz., wheat, rice, sugar-cane, oilseeds, cotton, and jute, the author has described in an illuminating manner the present conditions of trade in these materials and the measures which he regards as necessary for future development. He considers that with improved production "the need for efficient marketing arrangements would automatically assume greater significance," and observes: "The appointment of marketing officers and the formation of provincial boards, the attempts at developing communications, and the grants for uplift work in the rural areas are signs that better times have arrived. . . . The ultimate goal should be constantly kept in mind, and the policy now adopted should be pursued to its logical conclusion. . . . The salvation of India will depend on the manner in which her agricultural problems are handled."

CONSERVATION OF THE SOIL. By A. F. Gustafson, Ph.D. Pp. xvii + 312, 9 × 6. (London: McGraw-Hill Publishing Company, Ltd., 1937.) Price 18*s*.

The term "soil conservation" taken in its wider sense would include all agricultural practices which maintain the fertility and tilth of the soil. In countries where soil erosion is an ever-present menace the importance of its control looms large, and it is with this aspect of soil conservation that the present book is chiefly concerned.

The problem of soil erosion as it occurs in the United States is reviewed on the broadest lines, the thorough treatment and numerous illustrations making the book of particular interest to those wishing to study the subject as a whole. At the same time, in describing the various control methods the author has included a wealth of practical detail which will be of value to farmers and landowners.

In addition to the various forms of erosion by water (sheet erosion, gullying, and landslides), the effects of erosion by wind and by waves are discussed with suggestions for their control. Water erosion naturally receives the fullest treatment, and chapters are included on contour tillage, strip cropping, terracing, soil protection by meadows and forests, and the control of gullies by dams and the use of vegetation. The book concludes with two interesting chapters on special aspects of the subject, one dealing with the control of erosion on public highways, and the other with the control of floods.

SOIL EROSION AND ITS CONTROL. By Quincy Claude Ayres, C.E. Pp. xi + 365, 9 × 6. (London: McGraw-Hill Publishing Company, Ltd., 1936.) Price 21*s*.

The author states in his preface that this book is offered to meet the need for a general treatise on erosion control for the use of students in colleges and vocational agriculture departments, county agents, engineers, farmers, public officials, bankers, investors, and others who may be interested in the subject. The importance of a more general interest in the subject is indeed brought home to the reader by the statements of the appalling erosion damage in the United States, estimated in 1935 at a total of 35 to 50 million acres of cultivated land totally ruined and abandoned.

The treatment is essentially from a practical standpoint, giving quantitative information so far as is possible in a book of this scope, and far greater stress is laid on control methods based on agricultural engineering than on afforestation and allied practices. In the introductory chapters different types of erosion and the factors influencing them are discussed on general lines and possible methods of control are surveyed. The bulk of the book is taken up by a detailed study of terracing and gully control, which includes five chapters on terrace design and layout, methods of construction, machinery and costs, and also accounts of check dam building and the use of vegetation for the control of gullies.

The practical value of the work is considerably enhanced by the index, a bibliography of 217 items, and an appendix which includes lists and tables giving information required in actual design and constructional work.

MOTHER EARTH. Being Letters on Soil addressed to Professor R. G. Stapledon, C.B.E., M.A. By Gilbert Wooding Robinson, Sc.D. Pp. vii + 202, 7½ × 5. (London: Thomas Murby & Co., 1937.) Price 5*s.* 6*d.*

In this book an attempt is made to present the fundamentals of our scientific knowledge of the soil in a form which will appeal to those not versed in the more technical aspects of pedology. The treatment throughout is from an agricultural standpoint, indicating the bearing of the purely scientific side of the subject on agriculture, both at the present time and in the future. The work is not intended as a text-book covering the whole of the ground in detail, and is written in an informal style, as a series of letters addressed to Professor Stapledon, author of *The Land, Now and To-morrow.* Soil structure, moisture, and fertility are discussed in the first half, while the second is concerned with different types of agricultural soils and soil surveys, and concludes with a consideration of waste lands, erosion, and soil conservation.

POTASH DEFICIENCY SYMPTONS. By Prof.Dr.Agr.h.c. Oskar Eckstein, Albert Bruno and J. W. Turrentine, Ph.D., with the collaboration of G. A. Cowrie, M.A., B.Sc., F.I.C., and Dr. G. N. Hoffer. Pp. xii + 235, including 54 coloured plates and descriptions, 9½ × 7. (Berlin: Verlagsgesellschaft für Ackerbau m.b.H.; London: Thomas Murby & Co., 1937.) Price 8*s.*

This excellently produced volume should be of very great value to agriculturists. The three principal authors are in charge of the scientific work of the national potash organisations in Germany, France, and the United States, respectively, and the authoritative nature of the book could hardly be greater. The first part deals with general symptoms of potash deficiency, including its effects on the external appearance of the leaf, root, blossom, and fruit, and on the inner structure of the plant; the influence of a lack of potash on resistance to diseases, pests, and climatic factors; the relation between potash deficiency and the market value of crops; and the pathology of potash deficiency. In the second part potash deficiency symptoms on various cultivated crops are considered, Dr. Hoffer contributing a section on maize and other cereals and Mr. Cowie one on fruit trees. There is also a short section on vines. The most striking feature of this second part is the coloured illustrations which in 54 plates depict the changes which are undergone in the appearance of 45 different crops owing to lack of potash in the soil. The subjects covered range from cereals, pasture crops, vegetables and fruit trees to tropical crops such as cotton, sugar-cane, coffee, tobacco, etc. There are, in addition, 41 half-tone illustrations.

Each section of the book and the descriptions of the illustrations are printed in German, French, and English, so that the actual amount of reading matter is not great. Nevertheless it forms a very comprehensive summary of the present knowledge of the subject, as will be seen by the fact that the references in the Bibliography number over 200.

FOOD TECHNOLOGY. By Samuel C. Prescott, Sc.D., and Bernard E. Proctor, Ph.D. Pp. ix + 630, 9 × 6. (London: McGraw-Hill Publishing Company, Ltd., 1937.) Price 30*s*.

The authors, who are members of the teaching staff of the Massachusetts Institute of Technology, state in their Preface that they "have attempted to emphasise the fundamental principles involved in the various methods of food manufacture and treatment, rather than to give a highly detailed account of the manipulations carried out in each particular case." This work must therefore be regarded not as a detailed treatise, but as a general survey of the various food industries, with particular reference to United States practice.

There is an excellent introductory chapter in which the world position and economics of foodstuffs as a whole are discussed. The next eleven chapters are devoted to the individual foodstuffs: wheat and flour, corn and corn products, minor cereals, vegetables, fruits, sugars and syrups, meat and meat products, fish and fish products, poultry and eggs, milk, and dairy products. Then follow chapters relating to the processes of baking, canning, refrigeration, and dehydration. The 55-page chapter on canning has been contributed by Dr. A. W. Bitting. The remainder of the book consists of six chapters dealing with such processed materials as mayonnaise, coffee, tea, spices, jams, etc.

The authors have endeavoured to arrange the subject matter of each chapter so as to conform to a definite plan, but this has not always been possible owing to the very wide range of materials treated. The majority of chapters, however, begin with a statistical summary of the trade and economics of the particular foodstuff or process, followed by a short history of the industry. General information is then given regarding each product, how it is obtained, its properties and composition, and finally there is a survey of the more important methods of treatment or conversion involved in the placing of the final product on the market.

The book contains a number of useful illustrations, diagrams, and flow sheets.

Although it is intended primarily for readers in the United States, this book can be thoroughly recommended as an interesting reference book on broad general lines.

FOOD PREPARATION. By Marion Deyoe Sweetman. Second Edition. Pp. xi + 449, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1937.) Price 15s.

The study of food preparation as a science is a recognised subject in American college curriculum, and this text-book has as its primary purpose the presentation of appropriate subject matter for such a college course. The author, who is Professor of Home Economics at the University of Maine, contends that the science of food preparation is a branch of the larger science of nutrition, and that in the study of food preparation emphasis should not be primarily upon palatability, but that full consideration should also be given to nutritive quality, digestibility, sanitary quality, and economy.

In her first chapter she discusses on general lines these five criteria. This is followed by two chapters, one relating to the principles underlying the various processes used in food preparation both in the home and in industry, and the other in which the structure of foodstuffs is considered. The rest of the book, with the exception of a final chapter on meal planning, treats of individual foodstuffs or groups of foodstuffs. The materials dealt with are cereals, fruits and vegetables, milk and its products, eggs, fats and oils, meat and allied foods, sugars and their use in food mixtures, frozen mixtures, and flour mixtures. Each foodstuff is considered under several headings, viz., consumption in the United States, composition, structure, nutritive quality, and processing. There are also sections dealing with aspects specific to particular foodstuffs such as the malting of cereals, the artificial colouring of fruits, etc.

In the treatment of the subject matter the bias is of necessity on the side of food preparation in the home, and although commercial methods are also studied, the results are judged by the same standards that are applied to products prepared in the household.

The book has about 50 diagrams and illustrations, and at the end of each chapter will be found a list of references, which are intended to suggest material for supplementary reading.

COFFEE IN KENYA. By the Staff of the Scott Agricultural Laboratories and the Agricultural Economist, Department of Agriculture, Kenya, with a contribution by the Director of the British East African Meteorological Service. Edited by J. McDonald, D.F.C., B.Sc., F.L.S. Pp. vi + 210, 9½ × 6. (Nairobi, Kenya Colony: The Government Printer, 1937.) Price 5*s.*

This book is not intended as a text-book on the cultivation and preparation of coffee, but its object is to offer to planters some elucidation of the problems met with on Kenya plantations, based on the investigations and observations made by officers of the Department of Agriculture. After a section on the climate of the coffee areas of the colony by the Director of the British East African Meteorological Service, follow sections on coffee soils and their treatment, cultural practice and factory treatment, insect pests, diseases, and the economics of the industry, each contributed by the expert officer concerned. The advice given, based as it is on actual experience in the different coffee areas, should be of very great value to the planter. He will find here information as to the best means of maintaining the fertility of his soil, the kinds of green manures and shade trees which have proved suitable or are worthy of trial in the different districts, the most suitable methods of propagation and pruning, the fundamental principles of harvesting and preparing the crop in order to maintain a high standard of quality, and, not least important, descriptions of all the pests and diseases he is likely to meet on his plantation, with instructions how to combat them. Altogether, the book is an excellent tribute to the work being conducted by the team of research workers responsible for keeping up the high quality of Kenya coffee.

KAFFEE: EIN LEHRBUCH IN ENGER ANLEHNUNG AN DIE PRAXIS. By Paul Ciupka. Pp. 77, 8½ × 6. (Hamburg: Otto Meissners Verlag, 1937.) Price 3·60 gold marks.

In the author's preface this text-book claims to be a review of coffee as an important commercial product. It does, in fact, cover the whole ground of the subject of coffee in a thorough manner, but with great economy of style. After a historical introduction, there follows a description of the coffee plant, with notes on the various types and their geographical distribution, and a short account of cultivation, harvesting, and preparation. Part III contains facts about the chemistry and composition of raw coffee and its properties. Part IV describes commercial types of raw coffee, according to their countries of origin, and ends with a guide to the judging of the quality of coffee beans according to their external characteristics. Part V is devoted to roasting, blending, and sampling, whilst the sixth and final section gives analytical statistics of coffee production and consumption from 1900 to 1936.

KAFFEE-SCHÄDLINGE UND -KRANKHEITEN AFRIKAS. By Prof. Dr. H. Morstatt. Pp. 119, 9 × 6. (Berlin: E. S. Mittler & Sohn, 1937.) Price 3.60 gold marks.

This monograph is a reprint of a series of articles that appeared in the *Tropenpflanzer* during 1936-37. It is divided into seven sections, numbered I, IB-VI. The first section gives an account of the various kinds of borers that can attack coffee plants in Africa, the damage done by them, and the measures that should be taken to control them; stem diseases are treated in section IB. The remaining sections deal with the other pests and diseases from which coffee plants may suffer, and are arranged according to the parts of the plant attacked. Thus those affecting the stem, branches, leaves, flowers, cherries, roots, and seedlings are taken in order, their causes indicated, and methods of combating them described. The work is abundantly illustrated, and can be recommended as a most useful manual for the coffee planter in the African colonies.

DRUGS AND GALENICALS: THEIR QUANTITATIVE ANALYSIS. By D. C. Garratt, B.Sc., Ph.D., F.I.C. Pp. xiv + 422, 8¾ × 5½. (London: Chapman & Hall, Ltd., 1937.) Price 25*s*.

The present work has been compiled with the object of bringing together in one volume the more important material found disseminated through the literature during the last 20 years, dealing with the chemical analysis of drugs. The author, who is a drug analyst to the London County Council, has selected material which, as the result of his many years experience, he considers will be of most value to other analysts. Over three-quarters of the book is occupied with general monographs of the various drugs and galenicals arranged alphabetically, on the whole in accordance with the general scheme adopted in the British Pharmaceutical Codex; the present work being concerned, however, solely with the quantitative aspect of the subject.

The author has intentionally omitted the quantitative assays given in the British Pharmacopoeia as these are assumed to be readily accessible to the drug analyst. Separate sections of the book deal with Fixed Oils and Fats and with Essential Oils of pharmaceutical interest, special attention being devoted to methods for their detection and the question of adulteration. The methods for the analysis of essential oils recommended by the Essential Oil Sub-Committee to the Standing Committee on the Uniformity of Analytical Methods of the Society of Public Analysts are given, and the estimation of essential oils in flavouring extracts, drugs and spices is also dealt with. There are 12 appendixes, which contain methods for the determination of moisture by distillation, estimation of traces of metallic impurities, the determination of alkaloids, the alcohol content of drugs, and also the Stas-Otto extraction process, elimination of emulsions, and various useful conversion and correction tables.

The book is furnished with a bibliography containing some 560 entries, and a good index. It will undoubtedly prove of very considerable value to all those engaged in the quantitative analysis of pharmaceutical preparations.

ENZYME CHEMISTRY. By Henry Tauber, Ph.D. Pp. xii + 243, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1937.) Price 15*s*.

During recent years a large number of scientific papers have been published recording the results of research work, whereby the knowledge of the chemistry of enzymes has been considerably enlarged. It is the intention of the author to present only the more important of these results and material available in earlier text-books on the subject is not included.

After an introductory chapter of a general character, the succeeding ones are each devoted to a study of different groups of enzymes, e.g. esterases, proteolytic enzymes, amidases, carbohydrases, the zymase complex and alcoholic fermentation, etc. The author briefly refers to the recent investigations on individual enzymes and has arranged his material under the sub-headings of preparation, properties, chemistry, optimum hydrogen-ion concentration, estimation of activity, methods of activation and specificity.

The book forms a useful summary of recent additions to the knowledge of the chemistry of enzymes. Each chapter concludes with a bibliography of the papers referred to therein, and author and subject indexes are appended

CACTI. A GARDENER'S HANDBOOK FOR THEIR IDENTIFICATION AND CULTIVATION. By Professor J. Borg, M.A., M.D. Pp. xi + 419, 8¾ × 5¾. (London: Macmillan & Co., Ltd., 1937.) Price 21*s*.

Professor Borg has filled a gap in the English literature on cacti in producing this book, in which both the classification and cultivation of the plants are treated in a way which will appeal to the amateur and specialist alike.

The major portion of the work is devoted to descriptions of the principle species and varieties in cultivation, 1,188 species being included (out of a possible 1,582), while 93 are illustrated by excellent photographs. With this imposing total it seems unfortunate that the author has not found it possible to include some form of artificial key or conspectus of critical characters to serve as a guide in distinguishing the genera and larger groups of species. Technical language has been avoided as far as possible in the descriptions, which, although necessarily rather brief, are yet sufficient to give a precise picture of each species.

The "preliminary talk on *Cactaceæ*," which occupies the first 45 pages of the book, gives an outline of the organography of the plants, which is followed by a general treatise on their cultivation. Besides dealing with ordinary cultural practice, this includes the discussion of such aspects as the sowing and care of seedlings, vegetative propagation by cuttings and offsets, and by grafting, and hybridisation. In conclusion there is a summary of cultural notes as applying to different groups of cacti, a short bibliography, and a detailed index of plant names which includes both species and varieties.

ECONOMIC GEOLOGY. By H. Ries, A.M., Ph.D. Seventh Edition. Pp. 720, 9 × 5¾. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1937.) Price 25*s*.

Except for the fact that many sections have been abbreviated, the matter contained in the present revised edition of this well-known text-book differs but little from that in the previous edition, which appeared in 1930 and was noticed in this BULLETIN, 1930, **28**, 262. The chapters dealing with coal and petroleum have been revised, and, in a number of places, rewritten. The section on sub-surface waters has been omitted and that on silver-lead ores is now incorporated with lead and zinc. A paragraph dealing with sillimanite has been added to the minor minerals section and slight alterations have been made throughout the book, one of the most notable being a reduction in the volume of statistical data.

The present work is well up to the standard set by previous editions, though some doubt may be expressed as to the wisdom of making a number of alterations in terminology, particularly with reference to ore genesis.

INTRODUCTION TO THE STUDY OF MINERALS. By Austin Flint Rogers, Ph.D. Third edition. Pp. xviii + 626, 9 × 6. (London: McGraw-Hill Publishing Company, Ltd., 1937.) Price 30*s*.

The present edition of this American text-book follows very closely the lines of its predecessors which appeared in 1912 and 1921. The subject matter is divided into four parts under the following headings: Part I.—Properties of Minerals; Part II.—Description of Important Minerals and Mineraloids; Part III.—Occurrence, Association, and Origin of Minerals; Part IV.—Determination of Minerals.

In Part I the section on morphological characters has been augmented, and to the description of chemical properties has been added a useful new section on microchemical analysis by Dr. Lloyd W. Staples. In dealing with crystal optics the author has employed the symbols α, β and γ for the directions of the ellipsoid axes and n_α, n_β and n_γ for the indices of refraction along the respective axes.

Part II includes descriptions of 222 minerals, and the author has here introduced the term "mineraloid" to describe "naturally occurring amorphous substances with chemical composition and physical properties less definite than those of crystalline minerals." The American pronunciation of each mineral name is given as well as the German and French names.

Part III is essentially a very much condensed account of the science of petrography, and Part IV gives a set of determinative tables. There is an appendix classifying minerals and mineraloids according to chemical composition, and the book concludes with a combined index and glossary. A select bibliography is included at the beginning of the book.

From the point of view of English students the book loses some of its value on account of the unusual spelling of chemical names frequently adopted. It also suffers severely in places from lack of revision since the 1912 edition, and this is especially noticeable in the descriptive section where the remarks on uses and occurrences are very commonly quite inaccurate or obsolete.

INDUSTRIAL MINERALS AND ROCKS (Nonmetallics other than Fuels.) First edition. Edited by the Committee on the Industrial Minerals Volume. Pp. x + 955, 9 × 6. (New York: The American Institute of Mining and Metallurgical Engineers, 1937.) Price $6.00.

This large and comprehensive volume, the publication of which has been sponsored and financially assisted by the

Seeley W. Mudd Memorial Fund Committee, deals with all non-metallic minerals other than fuels. To cover such a diverse and extensive field a team of forty-seven contributors, each a specialist on his subject, has been recruited and their efforts have been skilfully co-ordinated by the Chairman and Editorial Board of the Committee on the Industrial Minerals Volume. Many of the authors are members of the staff of the U.S. Bureau of Mines, a department which afforded much assistance. Help was also obtained from the U.S. Geological Survey and the Canadian Department of Mines.

The work of such a body of men coupled with such a system of co-ordination should lead to excellent results and it does not need a detailed examination to reveal that a large measure of success has been achieved.

The volume consists of forty-eight chapters, each of which deals either with a single or with a related group of useful minerals or rocks. Of these no less than 70 are mined and used on a substantial scale. The comprehensive nature of the work is exemplified by the provision of special chapters on cement materials, mineral fillers, pigments, and roofing granules; the inclusion of sections on calcium chloride, air, helium, and carbon dioxide; reference to manufactured graphite, " lava " or calcined talc, carbon black and artificial mineral pigments, and polaroid as a competitor of Iceland spar.

In spite of the generally high standard and extremely useful nature of this volume there are certain shortcomings and omissions, the rectification of which would much improve a future edition. The planning of the chapters is not sufficiently uniform, and some have a section on the chemical analysis of the minerals and their products which would have been better left to books dealing specifically with that subject.

It is not unnatural to find American texts giving prominence to the industry and deposits of their own country, but this is no justification for often giving incomplete and out-of-date information concerning other countries, which is the principal criticism to be levelled against the compilation under review. There is a general lack of references to English literature and those quoted are often unsuitable or out-of-date; for instance, the sole reference concerning the important china clay industry " at " Cornwall is to a bulletin on the clays of Connecticut published in 1905.

Under magnesite there is a section on magnesium metal inserted to call attention to developments likely to influence the future of the magnesite industry. This section is entirely misleading as it takes no cognisance of the position in Europe and appears to be written in ignorance of the fact that the bulk of the world's magnesium is already being made from magnesite.

In spite of these criticisms the book is a veritable mine of information and is at its best when dealing with commercial mineralogy, political and commercial control, prospecting, exploration, and mining methods, tests and specifications, preparation for market, marketing and uses.

MINERAL RAW MATERIALS. Prepared by the Staff of the Foreign Minerals Division, United States Bureau of Mines. Pp. xviii + 342, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1937.) Price 30*s*.

A large measure of success can be claimed for the attempt which has been made in this book to present, within the compass of some three hundred odd pages, a concise account of the composition, mode of occurrence, sources of production, and principal uses of 32 of the major industrial minerals found in the world, and of the measures which have been adopted in 12 of the more highly industrialised countries to regulate the mineral industry.

In general, the format of the work bears a resemblance to that of the Minerals Year Book of the United States Department of the Interior, except that it is not written exclusively from a United States standpoint, and there are only two parts. The first of these is devoted to a consideration of the 32 minerals, both metals and non-metals, arranged alphabetically, and the second to the economic measures and problems affecting the mineral industry in Belgium, Canada, France, Germany, Italy, Japan, Norway, Spain, Sweden, U.S.S.R., United Kingdom, and the United States.

A common arrangement is adhered to in each chapter of the first part, which covers such widely different subjects as coal, iron ore, petroleum, mercury, talc, and vanadium. Each section is headed by three segmented circular diagrams showing the principal producing, importing, and exporting countries with statistics in thousands of units, usually metric tons, relating to 1934. There follows a very brief description of the particular ores and their usual mode of occurrence; an account of the more important deposits by countries, in order of their importance; the industrial uses of the metal or non-metal; and any substitutes available. In conclusion, a world production table for the years 1932, 1933, and 1934 is given for each mineral except the nitrates, and in all cases a world map showing the international movements of the individual mineral, together with national productions, apparent consumptions, imports and exports.

The extreme brevity which has been necessary in the first part has restricted the value of the book, and certain errors have been overlooked, for instance, the reference to kainite

(p. 181) as a compound sulphate of magnesium and chloride of magnesium. A number of errors of omission give the impression that the authors are not familiar with the many publications available on the mineral resources of the British Empire, and in particular of the United Kingdom. Thus, for instance, on p. 24, of the five English counties mentioned as producing barytes, two are non-producers, whereas the two chief producers (Devonshire and Shropshire) are not included. It seems strange, too, that on p. 52 there is no mention of the important Lancashire coalfield, although the Forest of Wyre is included, and again on p. 90, Cumberland haematite is omitted from the United Kingdom iron ores.

The second part of the book presents a valuable summary of the economic mineral position of most of the major industrial countries of the world, both by means of the letterpress and by tables of production of the 32 minerals dealt with in the earlier part of the book, for the years 1932, 1933, and 1934, and import trade tables by commodities for the years 1932 and 1934.

The authors are to be commended for the way in which they have compressed such a quantity of information into so small a compass.

GOLD DEPOSITS OF THE WORLD. With a Section on Prospecting. By W. H. Emmons. Pp. vii + 562, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1937.) Price 36*s*.

The author of this valuable work has attempted the difficult task of giving a comprehensive geological account of the world's gold deposits within the space of a volume of reasonable size. The difficulty is largely one of compression, and this has necessitated the adoption of an extremely terse mode of presentation of the subject matter which inevitably detracts somewhat from its interest and often makes reading a little trying. Nevertheless the task has been accomplished in a masterly fashion and the book gives on the whole a remarkably complete and accurate survey of a wide and difficult subject.

The introductory chapter opens with an interesting estimate of the total world production of gold in the period 1492 to 1935, and of the percentages which have been derived from the various continents, Africa, of course, predominating with 30·7 per cent. A brief description of the properties of gold and a map showing the position and geological eras of the gold deposits of the world are followed by a classification of these occurrences broadly into supergene enrichments, placers, and deposits associated with igneous rocks. The ensuing description of the morphology of batholiths, from which the author believes primary gold to have originated in gaseous emanations, however, bristles with technical terms the introduction of which seems to be undesirable, especially in a work of this character. The author then deals with the mode of formation of fractures over batholithic intrusions and proceeds to an account of the zones of mineralisation which are found around many of the larger intrusive masses. The chapter concludes with a very summary explanation of metallogenetic provinces and epochs.

The next six chapters, which constitute the bulk of the book, are devoted to an account of all the principal gold occurrences and most of the lesser ones, the arrangement being on a continental basis. Prolific use is made of specially drawn maps and sections showing the relation of particular ore bodies to the surrounding igneous and sedimentary geology, and these figures, though often very small, are invaluable to the reader in interpreting the text.

There is in this part of the book, however, some lack of balance. About 100 pages are devoted to gold occurrences in the United States (which ranks third among world producers) whereas Canada receives 69 pages, Australia 89 pages, and the whole of Africa 65 pages, of which the description of the Rand deposits occupies a mere 14 pages.

The final chapter, on prospecting, provides a summary of the nature of gold deposits in the light of the previous descriptions, the procedure to be followed in mapping new country with a view to finding gold-bearing structures, the value of such features as wall-rock alteration and lode-outcrops, and the relative disposition of placers and lodes. Precise treatment of the routine of prospecting is not included.

The book has a large index and throughout the text there are many footnote references.

EFFECT OF IMPURITIES IN COPPER. By S. L. Archbutt, F.I.C., and W. E. Prytherch, M.Sc. Pp. xvi + 134, 9¾ × 6. (London: British Non-Ferrous Metals Research Association, 1937.) Price 12*s.* 6*d.*

The world's consumption of copper is so great, and the range of its uses so wide, that a full knowledge of the factors that influence its properties is of the utmost importance. Since 1920 researches carried out for the British Non-Ferrous Metals Research Association at the National Physical Laboratory have added considerably to our knowledge of the effect of impurities on copper and accounts of the work done have been published from time to time in a series of reports, and in papers based on some of them.

The various results obtained have now been collected, summarised, and published in this Research Monograph No. 4, which gives a clear and concise account of a systematic study covering a very wide field, and should be of great value to those interested in non-ferrous metallurgy, especially those engaged in the production, treatment, and utilisation of copper and its alloys.

The first chapter contains an account of the procedure adopted and gives particulars of the mechanical tests applied and methods of chemical analysis adopted. In subsequent chapters the effect on copper of oxygen, hydrogen, sulphur, iron, phosphorus, silicon, bismuth, lead, arsenic, antimony, nickel, and silver, added one at a time, and then in pairs and so on, is discussed, and the fact that the addition of certain elements counteracts the deleterious effect of others is clearly shown.

Although it was impracticable to carry out a separate investigation for every combination of these elements, sufficient data were obtained to allow prediction with a fair degree of accuracy of the effects of any given combination. With a view to a more general application of the results, however, an additional investigation was made, which included a study of the segregation of impurities in large works ingots and also of the rolling of works ingots containing added impurities. The results sufficed to indicate that those obtained in the laboratory may be directly applied to works practice, if all relevant factors are taken into account.

The book throws light on many interesting problems; for instance, it is suggested that much of the brittleness which has in the past been attributed to the presence of bismuth and lead is more correctly classed with other forms of brittleness, all characterised by intercrystalline weakness. These include brittleness caused by low-temperature annealing of certain alloys; that produced under certain conditions by hydrogen in the absence of oxygen; and that referred to as "gassing," caused by the action of reducing gases on cuprous oxide. Again, in the chapter which includes nickel it is stated that the valuable properties usually attributed to the presence of this metal are more correctly related to the combined action of nickel and oxygen than to the metal alone.

It is interesting to note that the strong prejudice which appears to exist in industry against the presence of antimony in commercial copper, is not confirmed by the results of this research, and it is suggested that antimony may be advantageously introduced for certain purposes, but in order to utilise its advantages it appears desirable that nickel should be excluded when oxygen is present.

In the last chapter the comparative effects of impurities on the mechanical and physical properties of copper are discussed, and the results are illustrated graphically.

STATISTICAL YEAR-BOOK OF THE WORLD POWER CONFERENCE, NO. 2. Data on Resources and Annual Statistics for 1934 and 1935. Edited, with an Introduction and Explanatory Text, by Frederick Brown, B.Sc., F.S.S. Pp. 132, 11 × 8½. (London: The Central Office, World Power Conference, 36 Kingsway, W.C.2, 1937.) Price 20s.

The growth of comparable statistical records in foreign countries, as evidenced in the second number of the Statistical Year-Book, is still regrettably slow, but, despite this, considerable modifications have been made in the new volume. The most notable of these are the inclusion of two sections on the production, stocks, imports, exports and consumption of coke, and the production and distribution of manufactured gas

Some amendments have also been made in the resources tables, notably in Table 1. The Belgian coal reserves, estimated at 11,000 million metric tons, are now quoted as probable instead of proved, the Netherlands coal reserves have been increased from 212·5 million to 2,930 million metric tons proved, and the coal reserves of New Zealand, reported in 1934 to be 480 million metric tons, have been reduced to 270 million metric tons on the authority of a report issued in 1927.

In the tables of annual statistics a new feature is the inclusion of peat with brown coal and lignite.

The new section on manufactured gas, which includes statistics of production and distribution for 1934 and 1935, shows the United States consumption of gas to be far in excess even of the combined totals for Germany and Great Britain, the second and third largest consuming countries. A remarkable fact becomes evident from a consideration of Table 14c in this section, in which data for "gas unaccounted for" are given. It appears that this item is relatively much larger in Great Britain than in other countries, being 3·9 per cent. of the total gas available for consumption in 1935 as compared with 1·6 per cent. in Germany and only 0·72 per cent. in the United States in the same year. It is difficult to account for this discrepancy in a satisfactory manner, either by assuming it to be due to leakage or to errors in registration as between companies' or consumers' meters.

Generally, the value of the Year-Book has been augmented, and subsequent issues will do much to consolidate its position as an acknowledged and reliable collection of statistical data.

AKTIVE KOHLE UND IHRE VERVENDUNG IN DER CHEMISCHEN INDUSTRIE. By Dr. G. Bailleul, Dr. W. Herbert, Dr. E. Reisemann. Pp. 114, 10 × 6½. Second Edition. (Stuttgart: Ferdinand Enk Verlag, 1937.) Price RM. 8.

The interest evinced in the first issue of this comprehensive account of the manufacture, properties, and applications of active carbon, which was noticed in this BULLETIN, 1934, **32**, 629, has occasioned a second edition incorporating sections on certain new applications as well as extensions of the older processes.

A considerable amount of rearrangement of subject matter has been done by the authors. Thus, the section of the first article by Dr. Herbert dealing with capillary condensation has been transferred to the end of the part, and the two articles dealing with vapour extraction and the production of gasoline from natural gases have been grouped under the title " the adsorption and extraction of vapours from gases." One part has also been made of the articles which appeared as separate chapters in the earlier work and related to the use of active carbon for decolorisation purposes and for the purification of water. Finally, the article on methods of testing active carbon is now relegated to the end of the book.

The additions include a description of the stripping of benzene and gas oil from the gaseous products at the Ruhrchemie Fischer-Tropsch plant, a discussion of the peculiarities of gasoline production and the behaviour of active carbon, which appear in the second part, and an account of a suggested scheme for benzol recovery from coal distillation gases, which is included in the third chapter.

On the whole the book is little altered in subject matter but considerably re-arranged.

MAGNESITE AS A REFRACTORY. By A. W. Comber, F.I.C., Assoc.Inst.M.M. Pp. xii + 114, 7½ × 5¼. (London: Charles Griffin & Co., Ltd., 1937.) Price 4*s.*

This small but informative book is the eighth of the series known as " Griffin's Industrial Textbooks." The author, whose *Composition Flooring and Floorlaying* appeared earlier in the series, has carried out extensive research on the refractory properties of magnesite and its applications, and is therefore in possession of all the salient facts regarding the present state of the industry. In this volume he has carefully collected and condensed all the present available information and presented it in a manner equally attractive to the expert and the layman.

The book commences with an account of the historical aspect of magnesite as a refractory and of the iron-smelting processes which gave such a stimulus to the manufacture of basic refractories. The character and sources of magnesite and other magnesian minerals are then described, and the next two chapters are devoted to a discussion of the theoretical aspects of calcining various types of magnesite, and a description of the practical methods in use.

The author then gives an interesting account of the manufacture of magnesite bricks and a very full description of the chemical and physical properties of sintered magnesite. There is also a brief account of the manufacture and properties of electrically fused magnesite.

In the two following chapters the present position of magnesite in the steel industry and its other industrial applications are discussed, and the book concludes with a brief description of the magnesite deposits of the British Empire and their economic possibilities. The present trend of experimental work towards cheapening the cost of calcining by adding ferrous carbonate to inferior raw material is deplored, and the author suggests that research might more profitably be devoted to improving existing calcining plant and methods.

The work is well illustrated and contains appendices giving typical chemical analysis of commercial materials and a short list of classified references.

BOOKS RECEIVED FOR NOTICE

THE SOUTH AND EAST AFRICAN YEAR BOOK AND GUIDE FOR 1938. Edited for the Union-Castle Mail Steamship Co., Ltd., by G. Gordon Brown, F.R.G.S. Pp. lxxiv + 1167. (London: Sampson Low, Marston & Co., Ltd.) Price 2*s*. 6*d*.

PROBLEMS IN AGRICULTURAL MARKETING. By Deane W. Malott. Pp. xiii + 410, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1938.) Price 18*s*.

REPORT OF THE FOURTH INTERNATIONAL GRASSLAND CONGRESS, GREAT BRITAIN, July 8 to 23, 1937. Pp. xxxiv + 486, 9¾ × 7¼. (Aberystwyth: Joint Secretaries of the Congress, 1937.) Price 40*s*.

COCOON SILK. By C. H. C. Cansdale. Pp. x + 230, 8½ × 5½. (London: Sir Isaac Pitman & Sons, Ltd., 1937.) Price 12*s*. 6*d*.

PRACTICAL BRITISH FORESTRY. By C. P. Ackers, M.A., B.Sc. Pp. xviii + 387, 9 × 5½. (Oxford University Press; London: Humphrey Milford, 1938.) Price 15*s*.

ALUMINIUM-TASCHENBUCH. Achte Auflage. Pp. xviii + 377, 6½ × 4½. (Berlin: Aluminium-Zentrale, 1937.) Price R.M. 2.50 inland, R.M. 5.00 abroad.

BULLETIN
OF THE IMPERIAL INSTITUTE

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EMPIRE SERVICE AND THE IMPERIAL INSTITUTE

Extracts from an address delivered by Sir Harry Lindsay, K.C.I.E., C.B.E., Director of the Imperial Institute, to the Bath Branch of The Royal Empire Society at Bath on Empire Day, 24th May, 1938.

THE law of growth is an inexorable law of Nature. And it applies no less to national life than to biology, for nations must either develop or decline, go up or go under. But there is this difference between the law of growth as applied to Nature and to Nations, that whereas in Nature growth is a quantitative thing, the expansion of Nations may be either quantitative or qualitative or both. What chance has the British Empire of further quantitative expansion? Little or none. Its population is already over one-fifth of all humanity and its area is over one-quarter of the land-surface of the globe; it accounts for nearly one-third of the world's total trade. No, its further expansion must be qualitative. The traditions on which it was founded and the ideals which it has in view are the most vital part of its inheritance, for they represent the spirit which informs and inspires the whole. That inheritance, those traditions and ideals, must be passed on to future generations not merely untarnished but enriched and ennobled.

* * * * *

Another aspect of Nature is her extreme resourcefulness. She seems to go on untiringly producing type after type of living creature, endowing them in her workshop with all the equipment necessary to survival and then pitching them into the fierce competition of life, to make their own way as best they can. In the result, vast battalions of living things, orderly in the natural laws which they obey and yet so diverse that the human brain flags in the effort to compute them. Have you ever tried to apply the same thought to the laws of National Life ? Unity is, of course, a national ideal just as orderliness is an essential feature in the realm of Nature. But how different are the methods by which different races seek to achieve unity. Some nations believe in the motto " Unity through Uniformity "—and the result is a sort of regimentation, every man striving to assimilate himself to a common national type. Other nations, and we may say this, surely, of the nations constituting the British Commonwealth, aim rather at " Unity through Diversity." Like Nature, they admire resourcefulness as a vital principle, and call it originality. They believe in throwing out a great diversity of national types, coalescing to form the national character. They believe that out of such diversity there are bound to arise new types of character presenting greater originality than their fellows, thinking new thoughts and projecting new ideas, new ideals. They believe that such diversity and such originality are at the basis of all true progress, if the nation as a whole is quick to discard what is effete or retrogressive and to encourage what promises greater efficiency, sounder methods and wider vision. Under such conditions, unity may be more difficult to achieve ; but, when achieved, it will be unity with definite objectives in view and definite methods of reaching them. In other words, it will be a unity which carries with it from the long-term point of view the surest guarantees of sound national progress.

* * * * *

The Imperial Institute was founded in 1887, and opened six years later, in 1893, as a national memorial to celebrate Queen Victoria's Golden Jubilee. It is right that the Empire should possess at its heart one institution of this character. It exists with a twofold object—to promote the utilisation of the natural resources of the Empire and to make better known the life, the scenery and the industries of the countries which it comprises.

It will be remembered that the Empire Marketing Board, of blessed memory, was founded with a somewhat similar duality of purpose—the scientific objective which aimed at the promotion of economic development, and the frankly propagandist, which did much to secure publicity for Empire activities.

Now it seems to me that the justification (if justification is needed) for an institution such as the Imperial Institute may best be expressed as follows. Ask yourself a very leading question. What are the two finest services which can be rendered to the Empire as a whole ? I suggest the following answers :—

First, that the producers of the natural resources of the Empire should be given the best possible chance of improving their standard of living. Secondly, that the younger generation should be encouraged to know all that the Empire stands for. That first problem, of the standard of living, is a very difficult one. Some people try to base it on tariffs ; and, of course, there is little doubt that tariff preferences have done much to help the primary producers of the Empire. But tariffs and preferences and other political matters are outside the scope of the Institute, which is essentially non-political in its objects. Surely the truest and best foundation on which to build the prosperity of the primary producer is that of Science. It is exactly in this field that the Imperial Institute is able to help, investigating in its laboratories the natural products of the Empire and reporting on them in its intelligence and statistical offices. And, again, in the other field, that of publicity, the Institute makes better known to the younger generation of the United Kingdom, through its Exhibition Galleries, its Cinema and Empire Film Library, all essential facts relating to the life, scenery and industries of the Empire —in brief, all that the Empire stands for.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Indian, and Colonial Governments

A NEW CROTON SEED FROM NYASALAND

THE sample of Croton seed which is the subject of this report was forwarded to the Imperial Institute by the Director of Agriculture in December 1937. It was desired to ascertain the possible utility of the product as a source of oil.

The seeds were stated to be those of Croton trees grown in the Lilongwe district, botanical specimens of which had been forwarded to the Royal Botanic Gardens, Kew, where they were determined as *Croton megalobotrys* Muell. Arg. (= *C. gubouga* S. Moore).

The sample consisted of large, flat, ovoid seeds, from 0·8 to 1·0 in. long, 0·8 in. broad, and 0·5 in. thick. They had smooth, thin, brittle, woody shells, varying in colour from whitish-brown to brown, and enclosing a fairly hard, cream-coloured kernel with a central cavity. In 6 per cent. of the seeds the kernels were unsound or not properly formed.

The seeds consisted of shell, 37·4 per cent., and kernel, 62·6 per cent. The seeds averaged 2·4 grams and the kernels 1·6 grams in weight.

The kernels were found to contain 5·0 per cent. of moisture, and to yield on extraction with light petroleum 47·3 per cent. of oil, equivalent to a yield of 29·6 per cent. from the entire seeds or 49·8 per cent. from the moisture-free kernels. The oil, as extracted from the kernels with light petroleum, was a golden-yellow clear oil with a nutty odour. It was examined with the results given in the following table, which are shown in comparison with those recorded for the oils of *Croton tiglium* and *C. elliotianus* :

	Present oil.	*C. tiglium* oil. ("Croton Oil".)		*C. elliotianus* oil.***	
		(1)*	(2)**	(1)	(2)
Specific gravity at 15·5°/15·5° C. . . .	0·9292	0·937–0·960	0·940–0·955	0·9266	0·927
Refractive index n_D20° C. .	1·4756	1·4774–1·4804	1·4774–1·4804	—	—
Acid value .	1·5	—	—	4·2	3·6
Saponification value . .	196·5	200–215	205–220	201·5	191·6
Iodine value (Wijs, ½ hr.) .	129·2	102–108	102–118	138·5	147·0
Unsaponifiable matter, *per cent.*	0·9	0·6	—	—	—

* *Jamieson, " Vegetable Fats and Oils," p. 198.*

** *" British Pharmaceutical Codex," 1934, p. 702.*

*** *" Bull. Imp. Inst.," 1915,* **13,** *40.*

These results show that the present *C. megalobotrys* seeds are rich in oil and that the latter belongs to the " semi-drying " class of vegetable fatty oils.

In connection with this investigation it is of interest to quote the following from a paper by Goodson and Clewer (*Journ. Chem. Soc.* 1919, p. 923 T), where it is stated :—

> " Both the seeds and the bark [of *C. gubouga* = *C. megalobotrys*] have been used . . . in conjunction with opium in the treatment of malarial fever.
>
> " A preliminary examination of the bark and the seeds has been made by Mr. H. H. Green, B.Sc., in South Africa . . . who found that the ground bark caused purgation and emesis in dogs, but that rabbits were less sensitive to its action, although in doses of 1 gram per kilogram of body-weight it induced diarrhoea. In human beings administration of the bark according to Mr. Green caused an intense burning sensation in the throat, salivation and slight nausea, with, in some cases, a slight laxative effect. The seeds exert a similar action. Mr. Green further observed that the acrid substance to which these effects are ascribed is extracted to some extent by hot water, and readily by ether."

Goodson and Clewer were not able to isolate the acrid constituent to which the irritant properties of the bark are due, in a form suitable for investigation. They added that it is possible that the seeds, which they hoped to examine later, might prove more suitable for this purpose.

No record of the examination of the seeds of *C. megalobotrys* by Goodson and Clewer or by any other observers can be traced.

It would appear from the above statement that the oil of *C. megalobotrys* has some purgative properties. A similar property is shown, though in a more marked degree, by the oils of the allied species *C. tiglium* and *C. elliotianus*, both of which oils have been used in medicine in the United Kingdom, that of *C. tiglium* having been included in the British Pharmacopœia (1914) though omitted from the current (1932) edition.

In these circumstances it is very unlikely that *C. megalobotrys* oil would find an outlet for medicinal use, except possibly in the countries of production. If the oil could be offered in large commercial quantities it might find a market in the United Kingdom for use in the manufacture of soap, but for this purpose it would not realise more than £16 per ton in London at the present time (March 1938).

BEESWAX FROM THE GAMBIA

In a report on "African Beeswax" published in this Bulletin, 1935, **33**, 294, the results were given of an examination of samples of beeswax from the Gambia, including one taken from a consignment of native-gathered wax which had been clarified under the supervision of the Agricultural Department and sent to the United Kingdom for sale in 1935. A further sample was forwarded to the Imperial Institute by the Senior Agricultural Superintendent, Gambia, in September 1937. It was stated to represent cleaned beeswax, to which special attention had been given in the preparation, and it was desired that it might be examined to determine the percentage of dirt present and to ascertain how the material compared with the sample from the 1935 consignment. Information was also desired as to whether beeswax of the quality of the cleaned sample would find a market without further treatment, and if so, how it would compare in price with trade blocks of clean wax.

The sample consisted of a roughly hemispherical block of fairly hard, yellowish-brown beeswax. Its odour was slightly musty. The wax was fairly clean and homogeneous, but differed from the Gambia beeswax of commerce in not possessing a granular appearance when fractured and in lacking the characteristic odour.

The material was examined with the results summarised below, which are shown in comparison with those obtained for the sample of beeswax from the Gambia examined at the Imperial Institute in 1935.

The following results were obtained with the wax as received :—

	Present Sample. *Per cent.*	Previous Sample. *Per cent.*
Loss at 105° C.	0·1	0·1
Ash	0·03	0·04
Matter soluble in boiling water .	0·3	0·3
Dirt	0·5	0·2

After filtration through paper, the wax was found to have the following constants :—

	Present Sample.	Previous Sample.
Specific gravity at 15·5° C./15·5° C. .	0·9643	0·9651
Melting point (by open tube method) .	63·5° C.	64·0° C.
Refractive index at 40° C. . . .	1·454	1·4551
Acid value (a)	16·5	17·2
Saponification value (b) . . .	98·2	96·0
Ester value (b—a)	81·7	78·8
Ratio number $\frac{b-a}{a}$	5·0	4·6
Iodine value (Wijs, 3 hrs.) . *per cent.*	11·2	10·5
Hydrocarbons . . . *per cent.*	13·2	11·9
Salamon and Seaber's test (temperature of clouding)	58·4° C.	58·6° C.

The following tests were also carried out on the filtered wax in order to determine the presence or otherwise of certain specific impurities :—

Test.	Result.
Weinwurm's test for the presence of paraffin wax and ceresin	Negative result*
Test for the presence of stearic acid . . .	Do.
British Pharmacopœia method for the detection of the presence of fats, Japan wax, fatty acids and resin	Do.

* *Also in the case of the sample examined in* 1935.

These results show that the present sample contained 0·5 per cent. of dirt as compared with 0·2 per cent. in the case of the sample examined in 1935, and that the wax was of normal composition and closely resembled the previous material.

The beeswax was submitted to two firms of brokers and to a firm of importers in London, who furnished the following observations upon its commercial valuation and upon the desirability of cleaning the material before shipment from the Gambia.

In comparison with the Gambia beeswax of commerce the present sample of cleaned beeswax is rather darker in colour, and has neither the usual granular fracture nor the characteristic odour. These differences may be due to the original raw wax not being collected from the usual sources of commercial Gambia beeswax, or they may be attributable to the cleaning process employed. In the opinion of one of the firms of brokers and of the importers consulted the wax is of a quality which would be quite marketable in the United Kingdom and comparable with the usual Gambia wax, no further treatment being necessary. It would be worth from 105*s.* to 110*s.* per cwt. c.i.f. London (February 1938). The second firm of brokers considered that its appearance was against it and that it differed considerably from F.A.Q. Gambia wax: they stated, however, that it would be saleable, but only at a low price.

The results of the enquiries indicated that the trade is satisfied with the cleanness (i.e. the dirt content) of the consignments of Gambia beeswax which come on the London market at the present time. It is therefore considered that it should not be necessary for the wax to be cleaned in the Gambia before shipment unless the raw wax as originally produced is excessively dirty. Before expressing a definite opinion on the advisability of submitting to a cleaning process the raw wax from which the present cleaned sample was prepared, the firms suggested that it would be desirable to submit for their inspection a sample (1 or 2 lb.) of the raw wax as produced, but not cleaned as was the case with the present sample. After viewing such a sample of wax they would be able to advise whether any further treatment was necessary before shipment and if such treatment would be a remunerative proposition.

The opinion generally held is that the only treatment to which beeswax should be submitted prior to shipment is one in which the wax as obtained from the hive is placed on a sloping tray in the sun, whereby the wax is melted. The molten wax is allowed to drain from the tray through a straining material (e.g. canvas) into a receptacle, which is usually a calabash, gourd or a tin mould. When set, the block of wax is removed from the receptacle, and the bottom layer, which contains the major portion of the fine particles of dirt, pollen, etc., that have passed through the straining material, is scraped off. The scrapings are worked up with the next batch of crude wax from the hive.

Beeswax in the form moulded in a calabash is known in the trade as a " cup " ; in a gourd as a " saucer," and in a mould as a " brick."

In those districts or countries where the beeswax prepared as above is more or less uniform in colour, it is customary to re-melt the small blocks of wax, to bulk the molten wax thus obtained and to re-cast it into large blocks weighing about 56 lb. each. This is stated by the firms consulted to be the usual practice adopted for Gambia beeswax, and is to be recommended provided the above condition as to uniformity of colour prevails.

Where the " cups," " saucers " or " bricks " of wax differ considerably in colour, it is usual to export the wax in those original forms ; this practice is adopted in the case of Dar-es-Salaam wax. The object of this is to enable users to sort out the wax into the different colours, as the lighter-coloured wax generally bleaches more readily than the darker material.

The three main uses to which beeswax is put are for the manufacture of polishes, candles and electric cables. For all these purposes the imported wax is in most cases refined and bleached before use, either by the firms who use it, or by wax merchants. Such treatment entails the melting of the wax, when any dirt present is removed. There is therefore no object in cleaning the wax before export beyond the stage obtained in the simple process given above, provided the amount of dirt is not excessive. In general the trade is not in favour of such additional cleaning, except when essential. Moreover, it is very doubtful whether the cost of cleaning the wax before shipment would be covered by the additional price obtainable in London for the cleaned product. It may, however, be stated that a wax which is of attractive appearance and clean has a more ready sale than a less clean one, and may at times command a small premium. If the wax is very dirty there might be a difference of from 5*s*. to 10*s*. per cwt. between its price and that of a clean wax.

From the foregoing results and observations it will be seen that the present sample of specially-cleaned wax differs from the usual commercial consignments of Gambia wax in having a cheesy fracture instead of a granular one, and in lacking the strong characteristic odour of Gambia wax. According to two trade firms consulted this variation, though undesirable, would only slightly reduce the value of the wax. The third firm consulted took a more serious view of the difference in appearance, and considered that the value would be substantially lowered.

The difference in appearance and odour may be due to the source of the wax or to the cleaning treatment it has received.

In any event, unless the rough wax is excessively dirty, it would probably not be remunerative to clean it in the Gambia, since the bulk of the wax imported into the United Kingdom is refined by merchants or consumers before use.

Wax for export should be prepared by the simple process already described. It was suggested to the Agricultural Department that a sample of about 2 lb. thus prepared might be submitted to the Imperial Institute for examination and trade opinion, when advice would be given as to whether this rough wax is sufficiently free from dirt to be accepted as clean wax on the London market.

PINUS HALEPENSIS OLEO-RESIN FROM CYPRUS

Pinus halepensis, the Aleppo pine, is the most important timber tree of Cyprus. It occurs in pure stands in the forests of both the Northern and Southern Ranges of the island and also mixed with cypress in the Northern Range.

As already briefly mentioned in this BULLETIN, 1937, **35**, 510, the Forest Department in Cyprus has started a series of tapping experiments on the tree as a preliminary to the consideration of producing turpentine and rosin on a commercial basis. A sample of oleo-resin extracted in the course of these experiments from trees growing on the Northern Range was forwarded to the Imperial Institute in November 1937 by the Conservator of Forests. It was desired to ascertain the composition and value of the sample which was regarded as fairly representative of the oleo-resin obtainable and had not been cleaned or refined in any way.

The sample weighed about 15 lb. and consisted of a soft, opaque, semi-solid oleo-resin, pale yellowish-brown in colour and having the characteristic odour of common turpentine. The oleo-resin contained in suspension numerous small particles of bark, and also some fragments of wood which, although forming little more than 1 per cent. of the material, gave the sample a rather objectionably dirty appearance.

The material on distillation with steam yielded 18·8 per cent. of oil of turpentine, which was water-white and possessed the following constants :—

Specific gravity at 15·5/15·5° C.	0·8717
Optical rotation, $\alpha_D 22°$ C.	−17·5°
Refractive index, $n_D 20°$ C.	1·4724

On submitting 500 cc. of the oil to fractional distillation the following fractions were obtained at a barometric pressure of 760 mm. :—

Distilling at	*Per cent.*
152°—160° C.	55
160°—170° C.	33
Above 170° C.	12

The oil furnished on evaporation a non-volatile residue of 3·2 per cent., compared with a maximum of not more than 2·0 per cent. specified by the British Standards Institution for Turpentine Type I.

The oil was found to contain a large proportion of α-pinene, identified by the preparation of the nitroso-chloride which melted at 103°-104° C.

The rosin remaining after distilling off the oil of turpentine was of very unattractive appearance, owing to contamination with the vegetable debris referred to above, and for the purpose of investigation it was purified by solution in ether, which after filtration was removed by distillation under reduced pressure. The colour of the clear rosin thus obtained corresponded with that of American rosin Type "G" according to standards issued by the United States Department of Agriculture.

The rosin thus purified had the following constants, which are shown in comparison with the figures recorded for American rosin :—

	Pinus halepensis rosin.	American rosin.
Melting point (capillary tube method)	Softens at 68° C.; melts at 76° C.	Softens at 70° C. to 80° C.; melts below 135° C.
Acid value (direct method)	177·7	152 to 177
Ester value	4·7	Up to 30

The rosin was completely soluble in alcohol, acetone, benzene and oil of turpentine, and only partially soluble in a hot 10 per cent. solution of caustic soda.

The foregoing results show that the present sample of the oleo-resin of *P. halepensis* furnished a satisfactory yield of oil of turpentine, which consisted, like American turpentine oil, principally of α-pinene. Fractional distillation showed that rather too high a percentage of the crude oil passed over above 170° C. to warrant its classification as a high-grade oil of turpentine, and it would require to be refined in order to enable it to conform with the requirements of the British Standards Specification for Turpentine, Type I, which specifies that on distillation not less than 95 per cent. of the oil must boil below 170° C. at 760 mm. pressure. Oil which would fulfil the requirements of this specification could be readily obtained from the present oil by re-distillation, when it would be possible to exclude from it a small portion of the higher-boiling fraction. In practice the desired result would be obtained by changing the receiver before most of the higher-boiling oil distilled over. The higher-boiling oil which would subsequently be obtained would also find a market as a lower grade oil of turpentine.

The rosin obtained from the present oleo-resin was similar in character to American rosin, but differed from it in being only partially soluble in caustic alkalis. The importance of producing a good transparent rosin free from foreign impurities cannot be over-emphasised. In the present instance the rosin was purified by ether, as mentioned above, but in commercial practice probably the best procedure to adopt would be to mix the crude oleo-resin with some of the oil of turpentine from a previous distillation, and then to heat it to about the temperature of boiling water to render it liquid and enable it to pass readily through sieves to remove the larger chips of bark, etc. The mixture should then be run into settling vats and allowed to remain there for a day or so until the water and fine particles of bark had separated out at the bottom of the vat and could be drawn off. The clear resin mixture is then transferred to the still.

Samples of the rosin and oil of turpentine prepared at the Imperial Institute from the oleo-resin were submitted to (*a*) brokers and (*b*) importers in London, who furnished the following observations regarding them :—

(*a*) "A cursory examination leads to the opinion that the rosin is very good and equal to the production of America, France, Portugal, Spain, etc. The turpentine oil is quite good enough for boot polish, cheap paints, etc., and if a larger sample is supplied we will get one of the most important users of such oil for varnish and paint to test it. Regarding commercial values, American rosin ranges from £12 10*s*. to £17 per ton of 2240 lb. according to grade, and your sample would be classed as 'G' at £13 per ton, packed in wooden barrels of 3¾ cwt., an allowance of 20 per cent. being made for the tare. To-day's value of American Gum Spirits of Turpentine in barrels of 3¼ cwt. each, *ex* wharf London, is £32 5*s*. per ton (March 1938). The American barrels are of a particularly sound sort and all the other countries do their best either to imitate them or even to import them in bundles of staves, as the American package is known everywhere and is almost a 'trade mark' of quality.

"We note your remark *re* rosin being contaminated by bark and other substances. This is a point requiring care, as a few dirty shipments will do endless damage and is the chief reason of Greek rosin being looked at askance by all except the few whose process does not call for purity.

"We are at your disposal for any further information we can supply you with in the hope that you may be disposed to put our name before the responsible people in Cyprus."

(*b*) "We are interested to hear that the Government of Cyprus have under consideration the commercial exploitation of this material in the near future, and we are wondering what area is given over to its production. We are large importers of all manufactures of rosin and turpentine into this country and have for several years imported considerable quantities of Greek rosin. We are therefore fully conversant with this material. Greek turpentine does not come into this market, its best market being Central Europe, especially for the manufacture of synthetic camphor. However, there is quite a good market in the United Kingdom for Greek rosin provided it is competitive with other origins.

"The present market price for the turpentine would be in the neighbourhood of £15 to £16 per ton—possibly slightly more—and for the rosin about £11 to £12 per ton (March 1938). However, this latter market fluctuates considerably in a year and it is very difficult to give a price one could work on over a period.

" We wish to thank you for the analysis you have sent us, and if we can be of any further assistance to you, please let us know. We should be glad if you would keep us in touch with any developments which may arise."

The oleo-resin of *Pinus halepensis*, from which apparently Greek oil of turpentine is exclusively obtained, serves as a source of turpentine oil in other Mediterranean countries, particularly Italy, Spain and Algeria. The yield of oil from this oleo-resin is stated to vary from about 14 to 27 per cent., with an average yield of about 20 per cent.

There are many references in the literature to the examination of the oil of turpentine from *P. halepensis*. A sample examined by G. Dupont (*Compt. Rend.*, 1922, **174**, 395) was found to contain about 95 per cent. of *d*-α-pinene, 1·1 per cent. of bornyl esters and 3·8 per cent. of sesquiterpenes. Schimmel and Co. (*Report*, Oct. 1905, p. 67) showed that on the fractional distillation of a sample of the turpentine oil from this species, at a pressure of 754 mm., 90 per cent. of the oil distilled over between 152° and 160° C.

The physical constants of turpentine oils stated to have been distilled from *P. halepensis* and examined by various investigators differ to some extent, notably as regards the optical rotation. The above-mentioned sample examined by Schimmel and Co. had the following constants :—

Specific gravity at 15° C.	0·8631
Optical rotation α_D	+38° 41′
Refractive index $n_D 20°$ C.	1·4655

A sample of the oil distilled in Italy and examined by Palazzo (*Sch. Rept.*, 1922, p. 74) gave the following results :—

Specific gravity at 15° C.	0·8635
Specific rotation $[\alpha]_D$ 15° C.	+46·71°
Refractive index n_D 15° C.	1·[illegible]

Similar results are also recorded by Tomeo Lacrué for samples of *P. halepensis* turpentine oil produced in various Spanish provinces (*Sch. Rept.*, 1930, p. 85), viz. :—

Specific gravity at 20° C.	0·8561 to 0·8591
Optical rotation α_D	+40° to +49°
Refractive index n_D	1·4666 to 1·4699

On the other hand, samples of turpentine oil reported in each case to be derived from *P. halepensis* and distilled in Spain were examined by Dorronsoro in 1919 and by Fernandez in 1909 and furnished figures for the optical rotation differing markedly from those found by the above-mentioned observers. The constants of those Spanish oils were as follows :—

	Dorronsoro.	Fernandez.
Specific gravity . .	0·8721 to 0·8808 at 15° C.	0·8590 at 20° C.
Specific rotation $[\alpha]_D$.	$+0°50'$ to $+4°15'$	$-8°44'$
Refractive index n_D .	1·4688 to 1·4716	1·4654

The investigator Tomeo Lacrué, referred to above, stated that he considered that these oils examined by Dorronsoro and Fernandez were not pure, but had been mixed with turpentine oil derived from *Pinus laricio monspeliensis*, a species of pine furnishing a laevo-rotatory oil.

As already indicated, the oil of turpentine obtainable from the oleo-resin should be marketable either in the United Kingdom or on the Continent of Europe, whilst the rosin, if offered in a suitably clean condition, should be saleable in the United Kingdom in competition with American and other supplies of material of a similar grade.

JAK TREE RESIN FROM CEYLON

THE jak tree (*Artocarpus integra* Merr. = *A. integrifolia* Linn. f.) is a large evergreen tree widely cultivated for its fruit in India, whence it has been introduced into other countries of the Eastern tropics. It belongs to the natural order Moraceae and like other members of that family (e.g. *Castilloa* and *Ficus*) all parts of the tree contain latex. The latter is used locally as a bird-lime in Ceylon, Borneo and other countries, for which purpose it is evaporated until it yields a viscous product of the desired consistency. The composition of the latex has been the subject of investigation from time to time and some authorities have recorded the presence of caoutchouc. For example, Hooper (*Ann. Rep. Ind. Mus., Indust. Sect.*, 1905-06, p. 26) gives the composition of the dry material as caoutchouc 7·7 per cent., resins 90·3 per cent. and ash 2·0 per cent. Others have denied the presence of caoutchouc or analogous substances (see Willis, *Ann. Roy. Bot. Gard., Peradeniya*, 1901-2, **1**, 258, and Eaton, *Agric. Bull., Straits and F.M.S.*, 1910, 9, 54). All accounts agree that the bulk of the dry matter in the latex is of a resinous nature, but hitherto there appears to have been no record of any attempt to utilise this material commercially. The Imperial Institute was glad, therefore, of the opportunity of investigating the material and ascertaining its possible uses when a sample of the dried latex from Ceylon was submitted for examination by the Trade Commissioner in London in November 1937.

The sample consisted of a roughly rectangular block, measuring approximately 3½ in. × 3¼ in. × 2¼ in., of a dark reddish-brown, opaque, sticky, resinous material, pieces of which were sufficiently soft to be moulded by the fingers.

After cooling the original material in a refrigerator it was found possible to grind it; the resulting powder however did not furnish definite softening and melting points by the capillary tube method. Another portion of the original material was then melted in a small crucible and allowed to cool. The material was quite fluid at temperatures above 50° C., and was still plastic on cooling at 38° C.

The product was extracted successively in a Soxhlet extractor, first with acetone, then with benzene and then chloroform, and the results obtained, together with the amount of ash furnished by the material, are shown in the following table :—

	Per cent.
Material soluble in acetone	90·8
Residual material soluble in benzene	2·1
Residual material from benzene extraction soluble in chloroform	0·3
Matter insoluble in acetone, benzene and chloroform	6·6
Moisture, etc. (by difference)	0·2
Ash	2·4

The residual material soluble in benzene, which would contain any caoutchouc present in the original sample, after removal of the solvent consisted of a clear, rather dark reddish-brown resin, possessing none of the properties of caoutchouc.

The acetone-soluble portion, after removal of the solvent, consisted of a moderately hard, translucent, yellowish-brown resin, paler in colour than the original material. A determination of the softening and melting points, by the capillary tube method, was attempted. The resin darkened somewhat on warming, but it was not found possible to record any definite softening point; it melted, however, quite sharply at 60° C. to a clear liquid.

This acetone-soluble resin had an acid value (direct) of 6·5, and a saponification value of 41·9.

On treating 1-gm. portions of the acetone-soluble resin with 20 cc. of a number of organic solvents, and maintaining the solution at boiling-point until maximum solution had been affected, the following results were obtained :—

(*a*) The resin was completely soluble in hot acetone, benzene and chloroform, and almost entirely soluble in hot alcohol, ether and turpentine oil, but only slightly soluble in hot petroleum ether.

(*b*) After cooling the above solutions and allowing them to stand overnight, the resin was still in complete solution in the chloroform, and almost completely so in the benzene. The solutions in acetone, alcohol, ether and turpentine oil had, however, deposited greater or less amounts of a white, amorphous, resinous powder, the largest amount being deposited from the alcoholic solution. This white powder, after recrystallisation from alcohol, melted sharply at 76° C.

The acetone-soluble resin was almost insoluble in a hot 10 per cent. aqueous solution of caustic soda.

The material was submitted to the Imperial Institute Consultative Committee on Gums and Resins for an opinion as to the uses to which it could be put, and samples were subsequently examined by members of the Committee representing firms of gum and resin merchants in London. The general opinion formed was that it would be difficult to find an application for the material in the form of the present sample, though it might be possible to prepare a useful product from it, but the further investigation which would be necessary to determine this point would be warranted only if the material is likely to be available in commercial quantities.

Conclusions

The material submitted was a resin belonging to the class of soft resins. From the examination so far made its properties do not fit it for any of the major uses for which resins are in demand. On the other hand, it may be possible to find a purpose for which the natural resin or a modified form of it would be suitable, and it has been suggested to the Ceylon authorities that if the product could be collected regularly in large quantities a supply of at least 14 lb. of the material should be forwarded to the Imperial Institute in order to enable chemical investigation and trade trials to be conducted.

As already mentioned, some investigators have stated that the latex of the Jak tree contains caoutchouc, whilst others have recorded its absence. From the results of the present investigation it will be seen that the dried material now under report contained no caoutchouc.

ARTICLES

DEVELOPMENTS IN THE EMPIRE PULP AND PAPER INDUSTRIES

In view of the great importance of maintaining an adequate supply of raw material for the paper-making industry and the fears that have been expressed in some quarters that existing sources may fail to meet the ever-increasing demand, it has been thought that a brief survey of the position so far as it concerns Empire countries would be of interest to our readers.

At the present time about 90 per cent. of the paper produced in the world is made from wood—chiefly from coniferous woods. Many other materials could be used for paper-making; indeed, some 2,000 fibre-yielding plants are known, most of which are, theoretically, possible sources of paper pulp. In actual fact, the number of raw materials, other than wood, in commercial use is not very large and the supremacy of wood for paper-making purposes is not seriously challenged by any other material. The primary position of wood in this field may be ascribed to a variety of factors, both economic and technical. The vastness and accessibility of the pulpwood forests have permitted the growth of an industry of a correspondingly vast scale, and economic factors governing the cost of the material and of its conversion into pulp have been favourable. Technically, coniferous wood owes its predominant position to the unique suitability of its fibres for paper-making, and the versatility of the raw material, which responds to the different pulping processes and different methods of treatment during the manufacture of paper, yielding products as diverse in character as blottings and greaseproofs, newsprint and high-class bonds, tissues and krafts.

The great coniferous forests of the world are confined to three main areas—North America, the Scandinavian and Baltic countries, and Russia. Canada and Newfoundland are the only members of the British Empire falling within these forest areas and their important position as producers of wood pulp is shown by the following figures of world production :—

WORLD PRODUCTION OF WOOD PULP

(Thousands of Long Tons)

	1930.	1931.	1932.	1933.	1934.	1935.	1936.
United States .	4,134	3,937	3,357	3,818	3,961	4,398	5,103
Canada . .	3,232	2,829	2,378	2,660	3,247	3,454	4,005
Sweden . .	2,409	2,163	1,965	2,522	2,824	2,931	3,105
Germany . .	2,055	1,776	1,682	1,741	1,979	2,119	2,330
Finland . .	1,059	1,067	1,243	1,357	1,543	1,700	1,945
Norway . .	917	543	886	842	967	847	976
Japan (including Sakhalin and Korea) . .	636	575	564	637	705	736	773
U.S.S.R. . .	378	402	429	476	517	582	689
France . .	143	157	182	217	276	305	337
Austria . .	312	307	279	305	314	330	331
Newfoundland .	257	251	235	237	274	291	282
Czechoslovakia .	308	310	285	310	320	344	282
Poland . .	106	95	92	98	121	122	142
Italy . .	130	104	123	123	111	130	137
United Kingdom.	101	96	91	99	108	112	115
Netherlands .	91	90	95	96	99	103	106
Estonia . .	73	82	75	77	85	85	88
Switzerland .	76	66	65	69	76	72	71
Lithuania . .	55	45	39	49	55	53	58
Roumania . .	42	37	31	36	45	49	50
Latvia . .	24	6	15	22	23	26	32
Mexico . .	30	30	30	30	30	30	30
Belgium . .	25	25	25	25	25	25	25
Spain . .	20	20	25	15	15	15	(*a*)
Denmark . .	4	4	3	6	6	6	5
Total .	16,617	15,017	14,194	15,867	17,726	18,865	21,017

(*a*) *Figure not available.*

The figures are for total pulp production and include (*a*) pulp produced for export and for home consumption, and (*b*) pulp produced in combined pulp and paper mills and subsequently converted into paper in those establishments. As far as possible the figures have been compiled from official sources.

PRESENT POSITION OF THE INDUSTRIES IN COUNTRIES OF THE EMPIRE

Canada.—As will be seen from the world production figures given above, Canada, with an output of 4,004,862 long tons, valued at £18,567,656 in 1936, was the second largest wood pulp producing country in the world. This great quantity of pulp was manufactured almost entirely from coniferous woods (chiefly spruce and balsam fir) by mills most of which are situated in eastern Canada, principally in the provinces of Quebec and Ontario, although mills are also operating in British Columbia, Nova Scotia, New Brunswick and Manitoba. During 1936, 93 mills were in operation, of which 44 were pulp and paper mills, 25 were pulp mills and the remaining 24 were paper mills concerned solely with the conversion of pulp into paper. Canada's industry is essentially a newsprint industry, and in 1936 her newsprint production, which reached a record figure of 2,879,809 long tons valued at £21,157,155, accounted for about 85 per cent. of the total tonnage of paper produced in the Dominion. Canada, indeed, contributed considerably more than one-third of the total world newsprint production. With the United States, the largest newsprint consuming country at her door, Canada is favourably placed for the disposal of her products. Exports of newsprint paper to the United States amounted to 2,141,673 long tons at a value of £16,799,906 in 1936, i.e. about 74 per cent. of the Dominion's production for the year. Australia and the United Kingdom were the next largest consumers for this commodity.

The nature and magnitude of the Canadian pulp and paper industry is perhaps best summarised in the following statistics for the year 1936:—

			Quantity.	Value.
			Long Tons.	£
Paper and paper goods	Newsprint paper	produced	2,879,809	21,157,155
		exported	2,672,401	20,840,465
	Boards	produced	322,454	3,502,174
		exported	Not available	805,230
	Total	produced	3,399,401	29,731,480
		exported	Not available	22,292,666

			Quantity. Long Tons.	Value. £
Wood Pulp	Mechanical	produced	2,598,516	7,691,813
		exported	119,213	571,295
	Sulphite, bleached	produced	383,673	4,476,156
		exported	313,974	3,695,300
	Sulphite, unbleached	produced	660,012	4,001,724
		exported	100,972	730,942
	Sulphate	produced	244,191	2,058,057
		exported	106,607	1,119,502
	Screenings	produced	100,400	146,601
		exported	20,952	47,376
	Other wood pulp	produced	18,070	193,305
		exported	11,940	118,854
	Total	produced	4,004,862	18,567,656
		exported	673,657	6,283,269
			Cords.*	
Pulpwood	Used in Canadian pulp and paper industries		5,775,894	8,135,060
	Exported as such		1,235,755	1,664,272
	Total		7,011,649	9,799,332

* *Rough or unpeeled wood. All peeled wood has been converted on basis of one cord of peeled pulpwood as equivalent to 1·125 cords of rough or unpeeled wood.*

The chart opposite clearly brings out the phenomenal growth of the Canadian pulp and paper industry, which now constitutes one of the major industries of the Dominion and exercises a profound influence on the economic and social life of the country. Although this great expansion has mainly followed the great increase in the world demand for newsprint, the last few decades have also seen the birth and rapid growth of the manufacture of other types of paper product, e.g. wrappings, writing papers, tissues and boards.

Demands on the forests have been severe. Approximately 7,000,000 cords of pulpwood were cut in 1936, of which 1,236,000 cords were exported. Export of pulpwood, it should be noted, is restricted as being contrary to the interests of the domestic pulping industry. It has been alleged that the Canadian forests have been wastefully despoiled for the profit of the American newsprint concerns. Certainly, in the past, when supply of Canadian wood seemed practically inexhaustible, wasteful methods were employed. The Dominion is, however, becoming increasingly conscious of the need for a constructive forestry policy to preserve and protect her immensely valuable pulpwood resources. How great is the scope for efficient forest management and how tremendous the benefits it could confer, is demonstrated by estimates of the timber wasted by fire and disease, which is put at a figure at least as great as the present annual cut. Effective co-operation with the government in the evolution of plans for the conservation of her forests is probably the most important problem

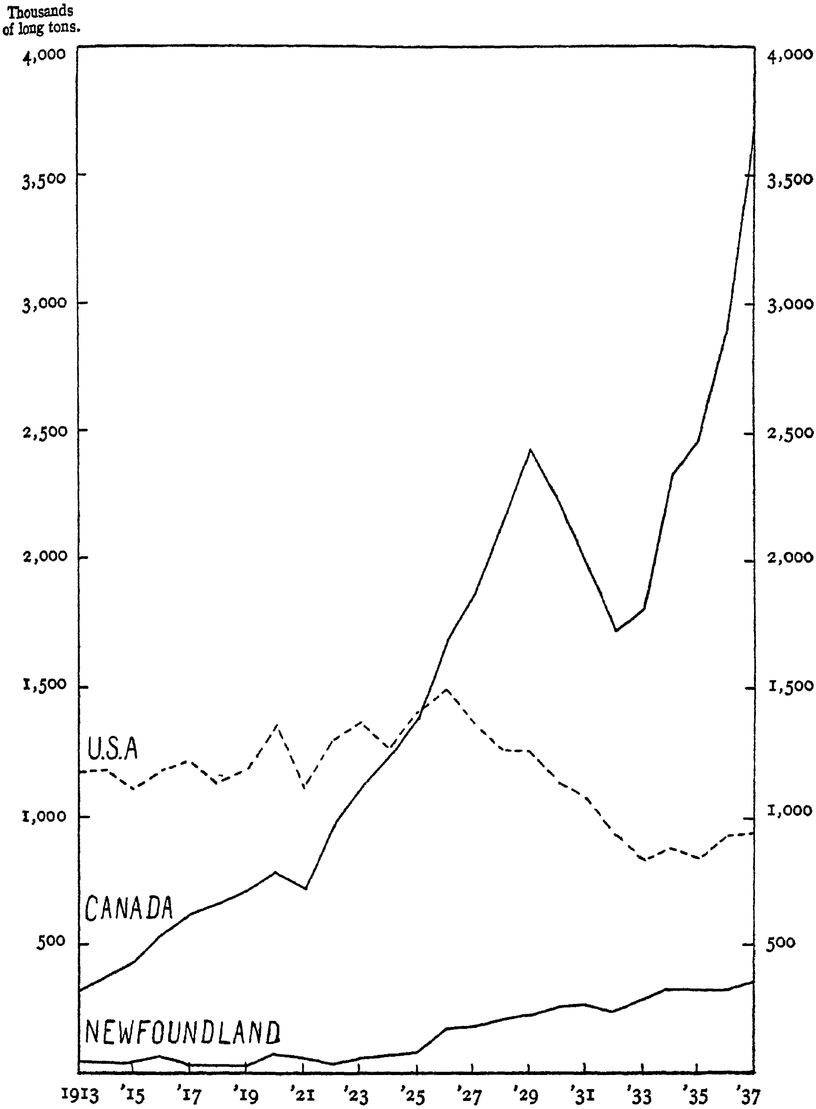

FIG. 1. NEWSPRINT PRODUCTION IN NORTH AMERICA.

facing the Canadian pulp and paper industry, which with large supplies of suitable raw material available, the water power and the mills, is strongly placed for development with further expansion in the world's demand.

Newfoundland.—The manufacture of newsprint paper fulfils an important rôle in the economic life of Newfoundland. In the year ended June 1937, 266,434 long tons of paper, valued at £2,674,117, were exported, and accounted for nearly 50 per cent. of the value of Newfoundland's total exports. The United Kingdom and the United States between them took the entire shipment, the mother country being credited with 193,380 long tons. No paper pulp was exported, but shipments of pulpwood amounted to 26,876 cords (of which 25,836 cords were peeled longs and 1,040 cords rough), valued at £36,308.

Two pulp and paper mills are at present operating, namely, the Anglo-Newfoundland Development Co., Ltd., situated at Grand Falls, and the International Power and Paper Co., located at Cornerbrook. Mention was recently made in the technical press of the possibility of a British newsprint company erecting a new sulphite mill on the east coast. At the moment the project remains in an early and indefinite stage.

Australia.—Australia has a well-established paper industry operating on imported wood pulp. Australian Paper Manufacturers Ltd., the largest paper and board organisation in the southern hemisphere, produces some 72,000 tons of paper and board, valued at £1,500,000 per annum.

For some time past the Australian paper industry, in co-operation with the Council for Scientific and Industrial Research, has been examining the paper-making value of local raw materials, particularly eucalyptus woods. The utilisation of these woods presented peculiar problems which have rendered necessary special modifications in pulping processes, and the important developments which are now taking place are the outcome of long sustained effort over a period of twenty years, and the expenditure on experimental work and economic investigations of, it is estimated, some £300,000.

The mills which are at present building or projected should, when they come into full production, be able to meet a considerable portion of the Commonwealth's paper pulp requirements. A large pulp and paper mill in northern Tasmania, which is now nearing completion, will use the soda process for pulping eucalyptus, and in Victoria, another mill now under construction, will pulp the woods by the sulphate process. A third project is not only of the greatest commercial importance but is also of considerable technical interest, since it has for its object the manufacture of newsprint from Eucalyptus (chiefly swamp gum, *Eucalyptus regnans* F. v. M.), and is the first occasion on which the use of hard woods for mechanical pulp has been attempted. A £4,000,000 company has been formed and has received the support of the Tasmanian Government and of the industries concerned. The company owns 123,000 acres of forest in northern Tasmania near Burnie, extensive pulpwood concessions situated along the Emu Bay railway, and 250,000 acres of forest concessions in the valley of the River Derwent and its tributaries. With regrowth on a 40-year rotation, these areas will be capable of permanently maintaining a pulp industry producing 100,000 tons annually. A suitable mill site has been chosen. The water of the River Derwent will be used, abundant electric power is available from the State Hydro-Electric Commission, and the labour supply is very satisfactory. The mill will be erected in stages, wood-grinding equipment and one newsprint machine with an output of 27,000 tons per annum comprising the programme for the first stage, which will cost over £1,000,000. Substantial production is expected by 1940. The Tariff Board are now considering an application for a bounty of £4 a ton on Australian newsprint.

Plans have been drawn up for yet another mill which it is intended shall make kraft paper. This mill will be located in the south-east of South Australia and its raw material will be, not indigenous timber, but *Pinus insignis*, of which Government and private plantations now cover 70,000 acres and may eventually extend to 150,000 acres.

In addition to the above-mentioned schemes for the exploitation of the Commonwealth's timber resources, the possibilities of other raw materials have not been neglected. Renewed interest has been taken in the plan, formulated some years ago, to manufacture Celotex from the bagasse burned for fuel by the Queensland sugar mills. The difficulty of providing a cheap alternative fuel is the chief obstacle. A proposal for the establishment of a mill in New Guinea to produce pulp from lalang grass (kurukuru grass, *Imperata arundinacea*) for export to Australia for conversion into fine printings and writings is heard of from time to time, but at the moment there does not appear to be any definite progress to report.

New Zealand.—New Zealand has three paper mills operating on imported wood pulp, and has under construction a pulp and paper mill, due to come into operation during 1938, which will make, in the first instance, board and subsequently newsprint, from New Zealand-grown timber. To begin with the mill will draw its supply of raw material from indigenous woods supplemented by thinnings from plantations of introduced coniferous woods, chiefly *Pinus insignis*, grown under Government afforestation schemes. Ultimately only *P. insignis* will be used.

Union of South Africa.—South Africa has also been anxious to develop the use of her local materials for the manufacture of paper pulp, and good progress has recently been made towards this end. In 1936 the Department of Agriculture and Forestry entered into a contract which guaranteed a local company 750,000 cubic feet of *Pinus patula* thinnings from plantations near Sabie, in the eastern Transvaal, for the manufacture of pulp for paper-making. The erection of the mill has been delayed, owing to the resumption of mining activities in the area, which created a difficulty in granting water rights for the mill, but this obstacle now seems to have been overcome. At the outset, a production of 4,000 tons of pulp per annum is aimed at, but it is planned to increase the output to 10,000 tons as the plantations grow older and more timber becomes available. Another mill under construction in the Transvaal will produce 36 tons per day of bleached or unbleached pulp from wheat straw and locally-grown *Pinus patula*. Other raw materials such as certain grasses, bagasse, maize stalks or bamboo may also be utilised in the future. The mill intends to use the new Pomilio (chlorination) process, which possesses a number of interesting features, among which may be mentioned that a continuous pulping method is employed, that a great variety of different materials can be dealt with by the same plant, that the initial cost of the plant is relatively low, and that salt is the chief chemical required. The process has, however, certain limitations, being workable only where cheap and abundant electric power is available and where the disposal of the alkaline effluents presents no difficulties.

A third South African mill is contemplated at George, in the Cape Province, where the Municipality has granted special facilities. The raw material will be *Pinus pinaster* wood derived from Government and private plantations in the vicinity.

India.—To India must be given the credit of having established bamboo as a paper-making material—the only commercially-important new raw material to be introduced into the paper-making industry since wood pulp came into use some sixty or seventy years ago.

Despite the size of her population India is a disappointing market for paper ; the demand for the better types is strictly limited, the principal requirements being for paper of the lowest grades. A local industry therefore labours under two initial disadvantages. First, it can neither operate on a large scale nor afford to undertake the manufacture of all the many grades and specialities demanded. Secondly, its products are of a higher quality and price than that for which there is the greatest demand, for with timber at its present price it is not possible for a chemical pulp such as bamboo to compete successfully with mechanical wood pulp made from spruce or balsam fir by a simple grinding operation. Not only is mechanical pulp manufactured by a relatively cheap process but a yield of about 90 per cent. is obtained, whereas a yield of only 50 per cent. or less results when chemical processes are resorted to. Chemical pulps are, of course, of much superior quality, but newsprint and the cheaper grades of paper generally are composed largely of mechanical pulp.

It has, however, been India's policy to give every encouragement to the establishment of a domestic paper industry utilising native raw materials, and with this aim in view protective measures were instituted in 1925 and renewed and modified in 1932. By the aid of these measures the industry has made good progress and is now firmly established. Indeed, last year the Indian Paper Makers' Association found it necessary to draw attention to the dangers of over-production arising from the fact that new mills with a productive capacity of 38,000 tons of paper of protected qualities were either under construction or were projected.

Trinidad.—A small mill for the production of paper pulp from bamboo has recently been completed.

The United Kingdom.—The United Kingdom is a very large manufacturer of paper and enjoys a high reputation for the quality of her products. According to the preliminary figures of the Fifth Census of Production (1935) issued by the Board of Trade, the total amount of paper manufactured in that year was 1,897,000 tons, the chief items being newsprint (857,000 tons) and boards of various kinds (381,000 tons). As far as wood pulp is concerned, and that commodity represents about 90 per cent. of the raw material, excluding waste paper, used in this country, the industry is chiefly devoted to the making of paper from imported pulp. The only exceptions are a large newsprint concern which grinds imported pulpwood for the production of mechanical pulp, and two other mills which import wood for the manufacture of sulphite pulp. Considerable quantities of esparto grass are, however, pulped in this country, and rag boiling is also practised.

Of the 1,600,000 tons of wood pulp imported into the United Kingdom in 1936, almost the entire quantity was derived from Scandinavia, only 16,000 tons, i.e. 1 per cent., being received from Empire sources (Canada and Newfoundland). Explanation is to be found in the geographical proximity of Canada to the United States markets, the financial interest of American concerns in the Canadian pulping industry and that of British firms in the Scandinavian supply, and in the definite policy of Canada to confine her export trade as far as possible to the finished paper in preference either to pulpwood or pulp.

FUTURE PROSPECTS

It will be evident from the foregoing review that the last few years have seen great activity in the manufacture of pulp and paper in Empire countries. Canada and Newfoundland have soared to record heights of pulp production, the other Dominions who hitherto have relied on imported pulp have made good progress towards the utilisation of their own forest or plantation resources; India has continued to demonstrate the usefulness of bamboo, and in the United Kingdom the paper trade has settled down to conditions more nearly normal after a period of high pulp prices and limited pulp supplies. Only in the colonies is there little progress to report.

The world position is such, however, as to afford the hope that even greater use will be made of Empire raw materials, and that Colonial products may eventually find a place as supplements to the wood pulp supply.

For it must be emphasised that the world consumption of paper pulp is rapidly rising. Pulp is required not only for paper and for different kinds of boards which are now used so extensively in making containers and for other purposes, but in addition the highest grades of sulphite pulp constitute the cellulosic raw material of many other industries. The rayon and staple fibre industries use specially prepared sulphite pulps as their raw material. Transparent cellulose sheet (e.g. cellophane) and certain plastics and lacquers are likewise all made from sulphite pulps. As has already been pointed out the world's supply of coniferous timber is mainly confined to the forest areas of Russia, the Baltic countries, and North America. Of these regions the timber stands of the Russian forests alone remain practically untapped. Much of the Russian forest area is, however, too inaccessible to be commercially important and, as her northern ports are icebound for many months in the year, she would have storage difficulties to contend with should she embark on a pulp export trade. The opinion widely held in the paper trade is that the development of Russia's pulpwood resources will no more than keep pace with her home consumption of paper, for her domestic requirements are increasing rapidly with progress in the industrialisation of the country. No large export of Russian pulp or paper is therefore to be anticipated.

The Scandinavian countries are in a position to maintain their present production more or less indefinitely, for they early set an example in the management of forest resources which the English-speaking countries have, to their cost, been slow in following. There is, however, reason to believe that the annual timber output of these North European countries is fast approaching the limit beyond which further cutting would lead to the permanent depletion of their forests. No great increase in European pulp production is therefore to be expected.

The Canadian forests will probably be fully taxed to meet the heavy requirements of the American newsprint presses. The Canadian industry is, however, liable to be influenced by the important developments which are taking place in the United States. The last year has seen a considerable expansion in the American industry, associated with the establishment of mills in the pine belts of the Southern states, where pulpwood prices and transport and conversion costs are lower than in either the Lake and Central Region or the Pacific Coast area. The total capacity of mills recently completed and of those now under construction is over 1,000,000 tons of unbleached and partially bleached kraft and to about 170,000 tons of fully bleached kraft. Furthermore, the establishment of a newsprint industry in the South must now rank as a definite possibility. Hitherto only non-resinous woods have been used for the manufacture of newsprint and the highly resinous mature wood of the species found in the South has been considered to be unsuitable for this purpose. It has been shown, however, that there is little resin in these pines until heart-wood formation begins, and research on the wood of immature trees has largely overcome the difficulties associated with the use of Southern pine for purposes other than kraft.

The foregoing summary, by neglecting those factors which afford relief to the situation, paints perhaps too dark a picture of the position of the world's pulpwood resources. Re-afforestation schemes, associated with proper forest management to eliminate the enormous waste due to fire, disease and insects, can maintain existing forests and increase their productivity. Certain new and hitherto inaccessible areas may be opened up. Technological research, which has already done much, may by the development of new processes and the modification of old ones, extend the number of species capable of being used for paper-making. And finally it must be remembered that great as is the quantity of timber cut for pulpwood—Dr. J. S. Bates, in his recent valuable paper to the Technical Section of the Paper Makers' Association, estimated world consumption in 1936 at 35,000,000 tons of air-dry logs—the pulp industry is not the chief drain on the world's forests, the lumber industry consuming considerably more timber than does the paper trade. Even a small decrease in lumber consumption is thus capable of releasing vast quantities of timber for paper-making purposes, and there are indications that the strain on forest resources is being relieved by a diminution of the lumber demand. Nevertheless, the fear of an imminent pulpwood shortage periodically grips the paper industry, and although so far such fears have proved groundless, the steadily increasing world demand for pulp cannot fail to favour the development of fresh areas and possibly to the use of new raw materials. Further expansion of the paper pulp industry within the Empire should, therefore, be possible.

The establishment of a new paper pulp industry is, however, an undertaking of considerable magnitude which can only be embarked on after the closest examination of all the factors involved. In the first instance, any potential raw material to be of value for paper-making must be available in large quantities, at a low cost, in a reasonably accessible area. Secondly, the cost of collecting the material and transporting it to the proposed mill site must not be excessive. These conditions being fulfilled, it will be necessary, unless the material is one with which the industry is already thoroughly familiar, to undertake a complete examination of its paper-making properties, beginning with laboratory scale operations and proceeding, if the initial work proves promising, *via* semi-large scale plant to a full scale trial. Yields must be determined, the most suitable method of pulping arrived at, and any technical problems which arise satisfactorily solved. It will then be known whether paper of an acceptable type and quality can be produced from the material under commercial conditions. If this proves to be possible, the economic position requires consideration. Developments in the Dominions have been favoured by the existence of considerable home markets for paper and the presence of local paper mills which can absorb the locally-produced pulp at the expense of the imported commodity. The position in the Colonial Empire is rather different, since the paper market is small and incapable of supporting a local pulp and paper industry, particularly as, paper-making being a specialised industry, one mill cannot manufacture all types of paper but must restrict its activities to the limited range for which a given pulp and mill equipment are suitable. Any colonial project will, therefore, most probably be based on export trade prospects and will have to be capable of surviving on its merits in the face of world competition. Export of the raw material itself, although possible, would probably be ruled out by high freight costs, unless a consuming country is situated close at hand. Of the remaining alternatives, the export of pulp would probably offer better prospects than the export of paper. If a paper mill were to be included in the scheme, considerably more capital expenditure would be involved, and only a limited number of grades of paper could be made, whereas, by confining activities to the manufacture of the pulp, the undertaking would be simpler, more adaptable, and less difficult to supply with skilled labour, etc. Whether the mill is to produce paper or only pulp, a site will have to be chosen which is conveniently situated in regard to the availability of supplies of chemicals and of fuel or electric power, and above all, the mill must be located on a good water supply, since water is required both for the washing of the pulp, and in the manufacture of paper, when some 200 tons of water pass on to the machine for every ton of paper made.

It is not, of course, possible to foresee accurately what developments will actually occur in the use of Empire raw materials for paper-making. It is, however, safe to anticipate increased production of wood pulp in the Dominions as more timber becomes available under afforestation schemes and the demand for paper advances with increase in the population and rise in the standard of living. As regards new sources of supply, the most natural development will be the establishment of pulp mills to work in conjunction with sawmills and use as raw material thinnings from the plantations and sawmill waste, such as the large limbs and tops of trees. Further use may be made of bamboo both in India and elsewhere, the pulping of lalang grass may be undertaken, and sisal waste may possibly prove of value. Moreover, if the Pomilio process justifies the hopes of its supporters, plant to operate by this process may be installed in areas where cheap electric power is available to make pulp from agricultural wastes such as wheat and rice straw, etc.

As regards the possibilities of new materials from Empire sources much remains to be done, but preliminary tests have already been carried out on a wide range of products, not only in this country, but in India, Australia, South Africa and elsewhere. The results of many such investigations which have been conducted at the Imperial Institute will be found recorded in the volumes of this BULLETIN for the past 25 years. They have included grasses and reeds from almost every part of the Empire; bamboos; industrial and agricultural waste materials, such as spent wattle bark, sisal waste, bagasse, cotton stalks and bolls, rice straw, sunflower stalks, etc. and numerous other fibrous plants. Of the Colonial woods which have been examined, reference may be made to a series of ten "secondary" woods from British Guiana and of eleven timbers commonly occurring in that Colony, which are likely to furnish considerable quantities of waste wood when the forests are eventually worked (1924, **22**, 14; 1928, **26**, 4; 1930, **28**, 411). In addition three timbers from British Honduras have been investigated (1925, **23**, 12); seven from Trinidad (1932, **30**, 1); five from Nigeria (1926, **24**, 8); and others from Southern Rhodesia (1934, **32**, 343), New Zealand (1921, **19**, 1; 1926, **24**, 654) and Zululand (1929, **27**, 449).

THE CULTIVATION OF LONCHOCARPUS

CONSIDERABLE interest has been taken in recent years in the use of the roots of certain species of Lonchocarpus as insecticides. These plants belong to the same section of the Leguminosæ as the well-known Derris, and their roots, like those of the latter, contain rotenone and were originally used by natives as fish poisons. The species concerned occur in the tropical regions of South America and the possibility of growing the plants in Empire countries where similar conditions prevail is under consideration.

In the course of working through the literature for a Monograph on Insecticide Materials now in preparation by the Consultative Committee on Insecticide Materials of Vegetable Origin, certain particulars relating to the cultivation of different species of Lonchocarpus have been collected. The information is scattered and not readily accessible and it is hoped that the present account, compiled from the available literature, will be of service to those interested in the experimental cultivation of Lonchocarpus.

The most important species entering commerce from Peru is *Lonchocarpus utilis* A. C. Smith (formerly described as *L. nicou* (Aubl.) DC.) where it is known as " cube." In Brazil the species chiefly concerned is *L. urucu* Killip and Smith, which is called " timbo " there. Among Spanish-speaking people of Latin America the term " barbasco " is used generically for all plants yielding roots of this type.

The plants in the natural state are large woody climbers which may reach the tops of tall trees, but usually under cultivation they are not allowed to remain after about four years, up to which age they have a bushy form.

HABITAT

The species of Lonchocarpus known to possess insecticidal properties occur principally in the Amazon Basin and on the lower slopes of the bordering hills and mountains. This region, which extends from latitude 3° N. to 15° S. and is bounded on the west by the Andes Mountains is a shallow saucer-like area intersected by innumerable rivers which form the drainage system.

In general there are two distinct topographical features of this region, the " varzeas " or flood plains, that is land subject to periodic inundations by the rivers, and " terra firme " or so-called " uplands " which lie above the flood limits. Practically the whole of the Amazon Basin is low-lying with only a few areas above 500 to 600 feet. The " uplands " themselves seldom rise more than a hundred feet or so above the flood plain, until they merge into the high land which comprises the lower slopes of the bordering mountains of the Basin.

It is mainly on the well-drained soils of the " uplands," and the bordering higher ground, that species of Lonchocarpus occur in a wild state.

In Peru, *L. utilis* is cultivated to a considerable extent in the comparatively low-lying country around Iquitos, while Killip and Smith [1] record that they found this species (then called *L. nicou*) thriving at 4,100 feet in the Montana, a region comprising the lowest Amazonian slopes of the Andes, although along the Apurimac River they were told it did not grow above 3,000 feet. Roark [2], quoting from a letter written by Killip in 1932, states that in Brazil species of Lonchocarpus are rarely cultivated above 2,600 feet.

The bulk of the Lonchocarpus exported from Brazil comes from the States of Para and Amazonas in the north.

TEMPERATURE

The climate throughout the Amazon Basin is on the whole very uniform, although local conditions may result in some variations in the rainfall and in the difference between night and day temperatures.

Few regular temperature records have been kept in the area, but it may be said that the temperature rarely rises above 93° F. in the shade and never reaches 105° F. At Iquitos the average temperature during the day is stated to be about 86° F. and at night 72° F. There is a mean maximum of 100° and a mean minimum of 62°.

In Brazil the temperature conditions in the Lonchocarpus producing areas of the north are very similar to those of Peru.

Lonchocarpus appears to require tropical conditions for its growth and cultivation. Experiments in the more temperate coastal districts of Peru have failed as the plants were unable to withstand the relatively low temperature, which at times fell below 50° F.

RAINFALL

Compared with many tropical countries the total annual rainfall in the Amazon Basin cannot be considered heavy. The torrential downpours common to many equatorial regions are quite unusual here. The annual rainfall is heaviest near the western edge of the Basin in Peru and Bolivia.

According to Wille [3] Lonchocarpus demands a fairly heavy rainfall, preferably distributed throughout the year. In the Montana the most rainy period is from October to May, reaching a maximum in January to April; the lowest rainfall is in July and August. In the wet season rain falls periodically throughout the night and when the dawn breaks the countryside is covered with mist. This generally disperses quickly and the sun shines until two or three o'clock in the afternoon, when heavy showers again begin. The average rainfall in this district is always more than 80 in. per annum.

The country around Iquitos also has a fairly heavy and well-distributed rainfall; one set of records shows 93 in. per annum. The rainy period is from October to May as in the Montana. The fact that the Iquitos district was formerly an important centre for the production of Para rubber will serve as an additional indication of the climatic conditions obtaining there.

The State of Para in Brazil has approximately the same rainfall as Peru, both as regards the amount and distribution, but from the few records available it appears that the annual rainfall in Amazonas is somewhat less and more seasonal. It seems probable, however, that the rainfall requirements of Lonchocarpus varies somewhat according to the species.

SHADE

The evidence as to the exact value of shade for the growth of Lonchocarpus is not entirely conclusive.

Several writers refer to it as being shade-loving, and Williams [4] states that in its natural habitat it occurs in thickets, in deserted overgrown clearings, and less frequently in dense forest growth, generally close to the margin.

When cultivated, it is usually grown in open clearings, although frequently interplanted with such crops as cassava. In discussing the cultivation of *L. utilis* Reategui [5] recommends that planting should be carried out in conjunction with some other crop such as cassava, as the young plants under these conditions do better than those having no shade in the early stages.

In Malaya it has been found that white haiari (*L. martynii*) rooted well under shade [6]. Beckett [7] in 1930 reported that in British Guiana both black haiari (*L. chrysophyllus*) and white haiari made excellent growth under partial shade. Later, in 1934, contrary evidence is recorded in the report of the Director of Agriculture for that Colony, where it is stated that these two species grow more vigorously in the open than under shade. This is in agreement with Howes's statement [8] that white haiari is often cultivated in the open by the Arawak and Warrau tribes of British Guiana.

On the whole it would appear that partial shade is probably beneficial in the early stages of propagation, but later under certain conditions more vigorous growth may take place in the open.

SOIL REQUIREMENTS

As regards soil conditions all species of Lonchocarpus appear to require a fairly open well-drained soil. *L. utilis*, for example, is said to grow well on sandy soils but not in places subject to periodic inundation by the rise of rivers. *L. urucu*, which is widely distributed throughout Amazonian Brazil, prefers *terra preta* (black soil, generally agricultural soil containing a good amount of humus), and is usually confined to the well-drained areas of " terra firme " occupied by high forest [9].

White haiari and black haiari occur on both sandy and lateritic soils in British Guiana, although they grow better on the former.

PROPAGATION AND CULTIVATION

In the principal producing countries Lonchocarpus is cultivated on plantations of various sizes often in the vicinity of dwellings. Killip and Smith [1], who visited Peru shortly before Lonchocarpus became an article of commerce, state that the cultivated areas or " barbascales " were found to vary greatly in size from small clearings of 25 to 100 plants intended to meet the fishing needs of a single Indian family to large plantations of as many as 10,000 trees, the source of supply for a whole neighbourhood.

Propagation by stem cuttings is universally adopted where the plant is cultivated, the native method consisting merely of burying a piece of the stem about a foot long at a depth of two or three inches below the soil. The following method for establishing a plantation has been recommended by the La Molina Experiment Station in Peru [3]. Cuttings should be taken from that part of the stem nearest the base, if possible with traces of roots attached. Cuttings of about 1 ft. in length, having two or three nodes, should be planted in the soil at an angle of 45°, one node being allowed to project above the surface ; a space of about 3 ft. should be left between neighbouring plants. The best time for planting in Peru is said to be September or October. The plants develop rapidly, and have usually reached a height of 3 ft. by the end of the first year, after two years they stand 5 to 6 ft. high, and at three years 8 ft. is generally attained.

Pinto [10], who carried out cultivation experiments with "timbo urucu" (*L. urucu*) and "timbo macaquinho" (*L. utilis*) at the Aprendizado Agricola do Para, Brazil, records a more rapid rate of growth during the first year, and states that at the end of twelve months from planting these species attained a height of about 7 ft.

One difficulty encountered in the cultivation of Lonchocarpus is the very heavy growth of weeds. This can be reduced to some extent by interplanting with crops such as cassava, beans, pineapples, etc., a practice which also permits of a more economical use of the land.

Harvesting of the root takes place at the end of the second, third or fourth year. The digging of the roots can be done at any time of the year but preferably when there is no rain, as at that time the work is easier and the roots can be removed in a cleaner condition. In Peru the best period is between May and August.

YIELDS

There would appear to be little reliable data as to yield. Killip and Smith [1] state that in the case of *L. utilis*, the average weight of the root system of a two-year old plant is 3 lb., which is equivalent to about 1½ lb. of dry material. Wille [3] considers that when the roots are harvested between the third and fourth years of growth, 2 kgs. of fresh roots can be obtained per plant, giving a yield of 4·4 to 4·8 metric tons per hectare. Pinto [10] in the experiments referred to above found the yield to be 3 kgs. of fresh roots per plant, but he does not say at what age the roots were harvested. According to information furnished to the Imperial Institute by H.M. Commercial Counsellor at Rio de Janerio, in Brazil the yield of fresh timbo roots, harvested 3½ years after planting, amounts to 17½ metric tons per hectare.

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PIEZO-ELECTRIC QUARTZ

Introduction

An unusual property possessed by crystals of quartz and certain other substances is that of generating an electrical potential when placed under stress. Thus if a plate cut in a particular direction from such a crystal is placed in tension or compression, a charge of measurable proportions is developed on the plate; conversely, if an electric charge is applied to the plate in a certain manner an immediate change in its dimensions results. This phenomenon, known as the piezo-electric effect, has been the subject of much study in the last few years, and wide use has been made of it in instruments employed in both ordinary and wireless telephony, ballistics and nautical depth-recording devices.

The piezo-electric effect is twofold. That part which may be described as the development of localised electrical charges on an asymmetrical crystal subjected to intermittent stress, was discovered in 1880 by the French scientists Jacques and Pierre Curie. The converse part of the phenomenon, the change of dimensions of a crystal under electrical charge, predicted by Lippmann in 1881, was also established by the Curie brothers.

Of the crystals examined by these investigators, Rochelle Salt (sodium potassium tartrate) was found to possess the highest piezo-electric constant, but quartz the best mechanical properties, and subsequent research has been devoted more to the applications of quartz than of any of the other members of the 22 crystal classes displaying piezo-electric effects.

Characters of Quartz Crystals

An ideal crystal of quartz takes the apparent form of a hexagonal prism, the faces of which are horizontally striated. The crystal is terminated by apparent hexagonal pyramids, but possesses trigonal symmetry so that the pyramid and prism faces are similar only alternately. The principal crystallographic axis joins the apices of the pyramids, and three axes of twofold symmetry perpendicular to the principal axis pass through the intersections of the prism faces. For piezo-electric purposes a further set of three axes is assumed which bisect the angles between the axes of digonal symmetry; these, however, have no crystallographic significance. In the recently published notation of piezo-electric quartz decided upon by the Department of Scientific and Industrial Research, these three types of axis are referred to respectively as the Z, X, and Y axes. In quartz, the Z crystallographic axis coincides with the optic axis.

The atomic structure exhibits a spiral arrangement in the direction of the Z axis and the direction of rotation of the spiral gives rise to left- and right-handed types of crystal which are about equally common. These two types may be distinguished by the disposition of the subsidiary faces which are sometimes developed between the prism and pyramid faces (figs. 1 and 2). It is not unusual to find both types of structure in one crystal, which is then said to be twinned. This is known as optical twinning since it may be detected by optical

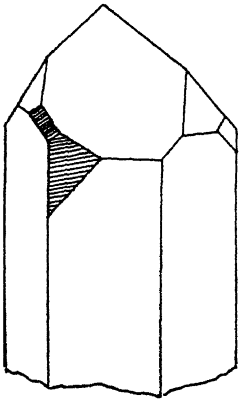

FIG. 1

LEFT-HAND QUARTZ.

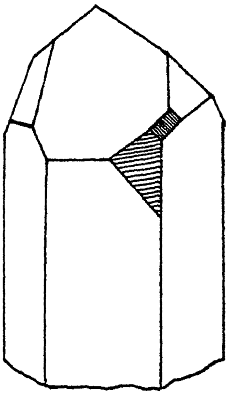

FIG. 2

RIGHT-HAND QUARTZ.

means. Commoner indications of optical twinning, however, are the presence of irregular growth lines (i.e. broken striæ) on the prism faces (fig. 3), and of natural etch figures mutually opposed to one another on the same prism face (fig. 4). These etch figures take the form of roughly triangular pits which can be developed artificially by means of hydrofluoric acid.

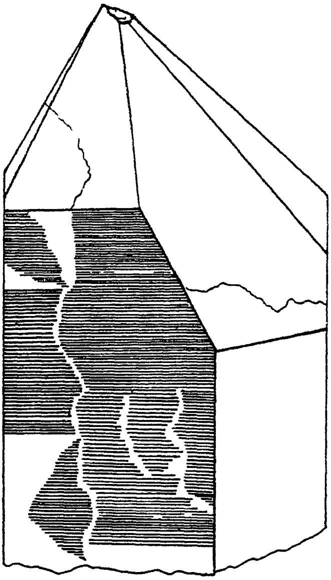

Fig. 3

Twinned Form.

Indicated by irregular growth lines on prism face.

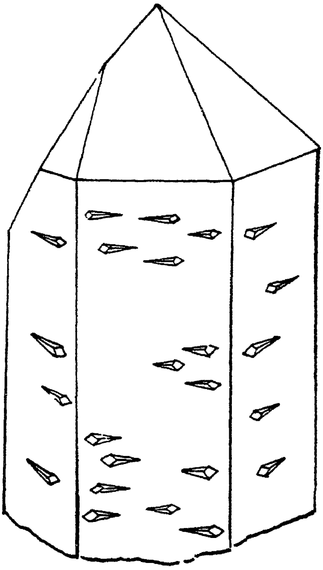

Fig. 4

Twinned Form.

Indicated by opposed etch figures on same face.

In addition to optical twinning there exists an electrical form produced by a 180° rotation of the structure about the Z axis in successive layers of a particular crystal, which results in the partial neutralisation of the electric charges generated on any one crystal face under stress. This variety of twinning is equally as common as optical twinning, and in both cases the asymmetry of the crystal is destroyed, and with it the ability to generate free electrical charges under unidirectional pressure. For piezo-electrical purposes it is essential, therefore, that the quartz shall be free from twinning.

Specifications and Prices

In order to be suitable for piezo-electric work, quartz must not only be untwinned but it must also be free from flaws, cracks, bubbles, inclusions or other such defects; it should not be unduly clouded, and should possess at least two natural faces of sufficient size to permit of the mass being orientated crystallographically. Except in very exceptional cases it is unlikely that any secondary faces will be developed whereby the presence of twinning can be detected in the hand specimen, so that etch figures, and growth lines, where evident on prism faces, furnish the best guides.

Specimens of good and bad quality crystals are illustrated in Plates II and III, which are reprinted from a report of the Post Office Engineering Radio Station, by kind permission of the Engineer-in-Chief of the Post Office.

Two crystals of the required type are illustrated in Plate II, figs. 1 and 2. These specimens are not appreciably twinned inasmuch as the growth lines are straight and parallel, all the faces are well defined, and the alternate faces are of uniform texture, one set being smooth and the other rough. Although the size limits of useful crystals are not rigid, those weighing between ½ and 5 kilograms are preferred.

Inferior material which shows excessive twinning and is thus unsuitable for the purpose in view, is illustrated in Plate III. Fig. 1 shows a twinned crystal in which the characteristics of the two alternate sets of faces are present in one or more faces, and the presence of twinning is revealed by marked discontinuity of texture at the twinning boundaries. A crystal of irregular and composite structure is illustrated in fig. 2 on Plate III. In this specimen the growth lines are irregular and discontinuous and the texture of the two sets of alternate faces is similar.

Several specifications are available for the guidance of sellers of piezo-electric quartz of which the following is typical.

Generalised Quartz Crystal Specification

(*a*) Crystals to be graded in four sizes, 1, 2, 3 and 4.

Grade 1.	Weight between 250 and 500 gm. Minimum width of prism face 30 mm.
Grade 2.	Weight between 500 and 750 gm. Minimum width of prism face 40 mm.
Grade 3.	Weight between 750 and 1,000 gm. Minimum width of prism face 50 mm.
Grade 4.	Weight between 1,000 and 2,000 gm. Minimum width of prism face 60 mm.

(*b*) Minimum ratio of lengths of opposite sides of crystal base 3:2.

PLATE II

Piezo-electric Quartz

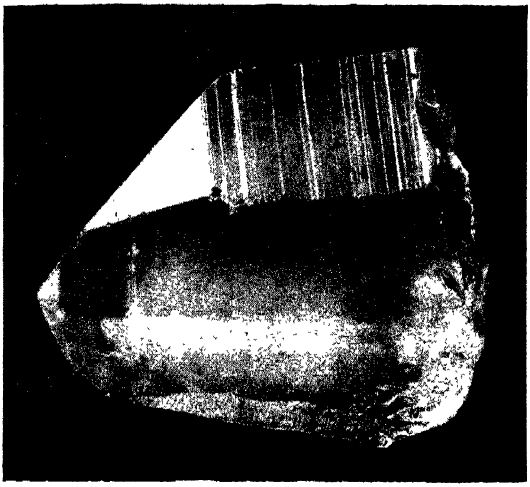

Fig. 1

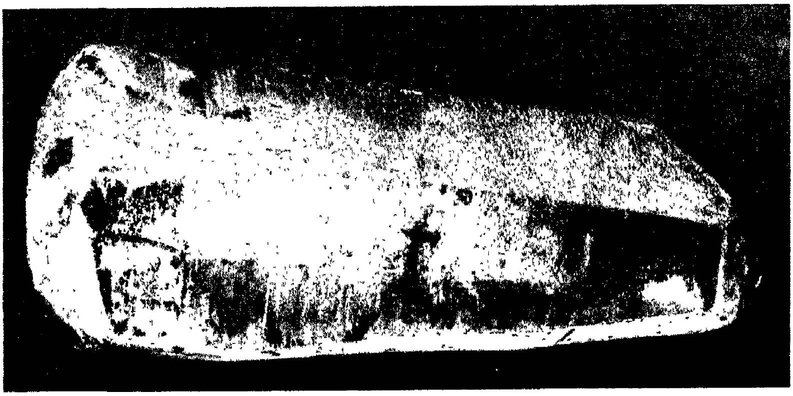

Fig. 2

Crystals suitable for piezo-electric use.

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PLATE III

Piezo-electric Quartz

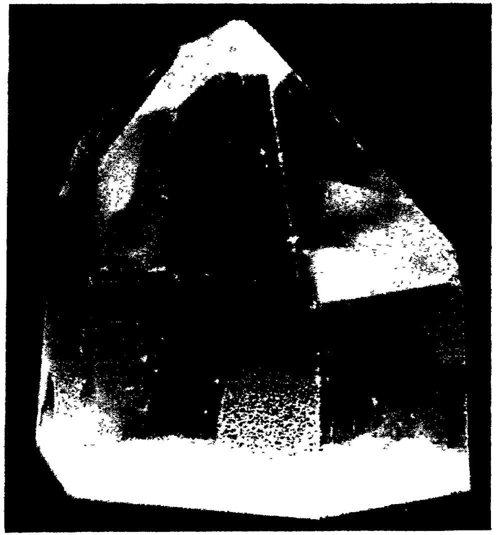

Fig. 1

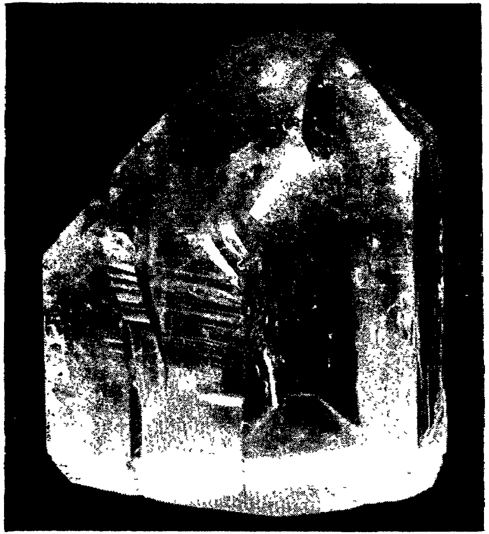

Fig. 2

Crystals rendered unsuitable by twinning evidenced by discontinuities in surface texture and growth lines.

(*c*) Vertical projected height of longest pyramid face not to be greater than one-third of useful height of crystal.

(*d*) Area of cross section of base should not change appreciably for 50 per cent. of crystal height.

(*e*) Crystal pyramid to have a minimum of three good faces; area of smallest face not to be less than 1 sq. cm.

(*f*) Crystal to be free from cracks and flaws for three-quarters of its total length.

(*g*) Crystal to be free from ghosts, discoloration, inclusion of foreign matter or from other crystals.

(*h*) Growth lines on prism faces to be straight and parallel.

(*i*) Appearance of prism face not to show any marked changes.

(*k*) Crystals not to be so water-worn as to prevent positive identification of the prism and pyramid faces.

This specification is a stringent one, but a certain degree of relaxation is permitted.

The prices of approved material vary widely, but for good quality crystals weighing from ¼ to 1 kilogram up to 35*s*. per kg. has been offered; for larger crystals weighing from 1 to 3 kg. up to £5 per kg. has been offered.

Cutting

The derivation of piezo-electric plates from the rough quartz commonly available requires a considerable amount of optical and lapidary skill in the determination of the crystallographic axes and the subsequent cutting and lapping of the blank to a predetermined frequency.

Optical and X-ray methods are available whereby the directions of the crystallographic axes may be determined.

The procedure in the case of more perfect crystals consists initially in aligning the specimen in a cutting machine so that the cutting disc passes through in a plane perpendicular to the Z axis. One method employed in this country to orientate the quartz utilises the pyramid faces, which lie at a constant angle of 38° 13′ to the Z axis. A jig consisting of a milled base plate carrying an arm set at 51° 47′—the complement of the pyramid angle—is used to fix the quartz for cutting in the desired position with reference to a metal holder. Parallel cuts are made so as to obtain a number of slabs which, in a perfect crystal, would be hexagonal in section (fig. 5). In the United States good crystals are gang-sawn to accelerate production and to ensure parallel cuts being made. Each slab then forms the material for the particular type of quartz plate desired, the second stage of cutting taking place perpendicularly to the hexagonal section, after an examination for optical twinning has been made by means of a polariscope, and for electrical twinning by etching the blank with hydrofluoric acid, which will corrode irregular areas if this type of twinning is present.

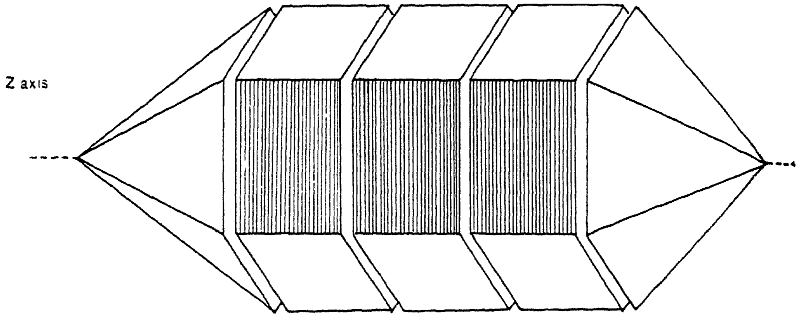

FIG. 5

IDEAL CRYSTAL SHOWING METHOD OF CUTTING BLANKS.

In the case of quartz blocks displaying neither recognisable faces nor growth lines, it is necessary to determine the position of the Z axis. One method is to cut from the mass three small sections dispersed as widely as possible, and all perpendicular to one another; this disposition ensures the optic or Z axis lying within 45° of two of them. These plates are each polished and marked with a reference line in indelible ink, then mounted, outer side uppermost, with this line horizontal, in an oil bath on a simplified universal stage. By orientating the plates so that the optical interference figure becomes centrally visible in a microscope attachment, the angular displacement of the optic axis from the horizontal line may be noted. The sections are then refixed to the original block, and, employing the reference line and the determined angles, the position of the optic axis in the mass is marked. Cuts are then made in a direction perpendicular to the optic axis.

The piezo-electric plates employed by the Curies and other early investigators were usually thin rectangular prisms cut perpendicular to an X axis, and parallel to a Y axis. This type of section is now known as an " X-cut " plate, though in the United States it has been the practice to call this a " Zero-cut " (fig. 6).

A second type of cut, perpendicular to a Y axis, was subsequently developed, and this has been referred to as a " 30°-cut " since the plane of such a plate lies at 30° to an adjacent X axis. More recently this particular section has been termed a " Y-cut " (fig. 6).

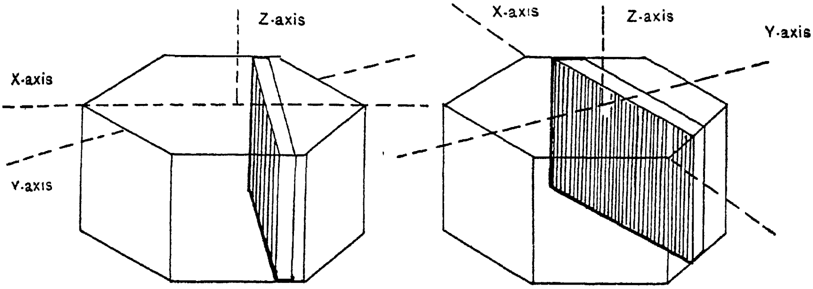

FIG. 6

X-CUT. Y-CUT.

" Z-cuts " are, of course, not made since quartz is piezo-electrically inactive in this direction.

The X- and Y-cut plates have found considerable use both as oscillators and resonators. Because of the comparatively large frequency-temperature coefficients of these plates, however, they have been replaced to a large extent by plates cut in other directions which have virtually zero frequency-temperature coefficients. These are of two varieties (see fig. 7),

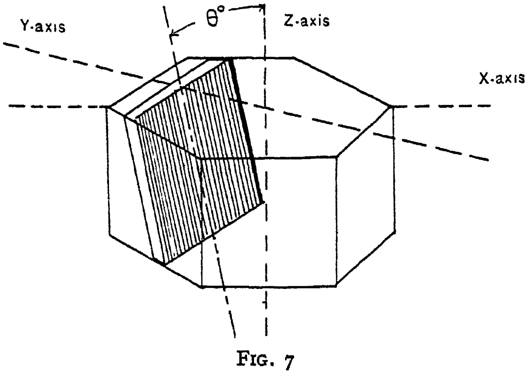

FIG. 7

$Y_{\theta T}$- AND $Y_{\theta C}$-CUTS.

in both of which the cutting plane is at an angle to a plane containing the Z and an X axis. The angle is determined by the frequency of the plate required, and in the variety known as the YθT plate is normally 35° with a range of variation of ±2°. The other variety, known as a YθC plate, was introduced to overcome the double frequency effects which simple Y plates tend to exhibit. The cut resembles the YθT, but is at a slightly different angle (31°) to the ZX plane.

Other cuts which have been made from quartz crystals include rods, cylinders and rings.

Modern Applications

The early work on piezo-electricity was concerned more particularly with the determination of the piezo-electric constants of quartz plates subjected to steady pressures, the resulting charge being collected by metal electrodes in contact with, or in close proximity to, the plate. It was not until shortly after the War that an American scientist, W. G. Cady, directed his attentions to the converse effect, and by applying an alternating current to the electrodes of a piezo-electric combination, produced a rapid vibration of the intervening quartz plate. He applied this property to the provision of highly reliable radio frequency standards for comparative purposes, and also frequency stabilizers, and these uses have proved to be two of the most important to which piezo-electric quartz is now put.

Quartz was speedily adopted as a resonator in wireless transmitters, the number of which both for commercial and general broadcasting purposes was rapidly increasing, especially in the United States. By reason of the large and varied supply of plates available in that country, the frequency of the transmission is controlled at most stations to-day by quartz-plate oscillators. In the United Kingdom, most continental countries, and in India, however, where changes of frequency under international agreements are likely to be common, most broadcasting authorities have hitherto favoured the high-precision valve type of control except for short-wave transmission. The total quantity of quartz employed in the radio industry is not considered to be large.

Telephony has so far provided a major outlet for piezo-electric quartz, the British Post Office having employed plates of this type since 1925, and the recent development of the co-axial cable is likely to increase the quantity employed considerably. This type of cable, which consists of a copper wire running inside a thin cylinder of copper tape and insulated from it by rubber discs or a loose spiral of cotton cord, is capable of carrying a wide range of higher order frequencies. Several hundred conversations can be transmitted simultaneously, the actual number depending on the width of the frequency band allotted to each. The division of the range of frequencies into bands is achieved by quartz-plate resonators located at the terminals of the cable.

Cables of this type have been laid between New York and Philadelphia, between Berlin and Leipzig, and between London and Birmingham, with a projected extension through Manchester, Leeds, and Newcastle, to Edinburgh.

The cable laid between London and Birmingham contains four co-axial tubes, the repeater stations being fixed at 7-mile intervals. This provides for a frequency range on each tube of from 500 to 2,100 kilocycles per second, and each tube is expected to transmit 400 telephone conversations or function as one television channel.

At the terminal stations the band filter-plates are X-cut; they measure 42·51 × 21·25 × 0·734 mm. and have gold electrodes deposited on the main surfaces by the electrical discharge process known as "spluttering." The master oscillators, employed to drive the circuits, each incorporate a Yθᴛ-cut quartz plate operating at 400 kilocycles per second and maintained at constant temperature in a thermostatically-controlled oven.

The complete equipment necessary for the four 125-mile channels between London and Birmingham (two being used as "go" circuits and two as "return") would require as many as 24,000 quartz plates, which is equivalent to approximately 1 ton of rough quartz. In the proposed extension to Edinburgh, a further distance of 330 miles, it may be assumed that another 3 tons of quartz would be needed.

Piezo-electric quartz is also extensively used in marine depth-sounding apparatus. Several quartz plates cemented between electrodes in the form of steel discs are fixed in the outer skin of the ship's hull. These plates are made to vibrate for an instant at high frequency and so generate a highly directional wave which is reflected from the sea floor and received by the same plates. The rate of propagation of the wave and the time interval between its emission and return are the factors from which the depth is derived. In the most modern apparatus the record of the ocean depths is taken and plotted continuously throughout the voyage.

Quartz plates are also used in research on ballistics, the almost instantaneous pressure developed by a propellant charge in a gun barrel being measured piezo-electrically. The procedure, which was originally devised by J. C. Karcher in 1922, consists in recording the electric charge developed on a quartz plate by the impinging explosion wave by means of a galvanometer, the deflection of which is photographed on a rapidly moving film. In large calibre guns a stack of quartz plates fixed in a steel plug is used, the plug being screwed into the breech block of the gun and a unidirectional pressure obtained by means of a plunger.

A new device employing a dual piezo-electric quartz system for measuring detonation in high-duty aero-engines was recently exhibited by the Air Ministry.

The piezo-electric properties of quartz have also been applied in the construction of extremely accurate clocks. At the National Physical Laboratory, D. W. Dye employed a ring of quartz cut perpendicular to the Z axis, excited by six electrodes evenly spaced round the periphery and connected alternately to leads from an A.C. supply. Later, a similar ring vibrating at 20,000 cycles per second was made to drive a synchronous motor and produce a record on a chronograph drum. Besides its great accuracy, such a device enables a much shorter time interval to be used than the two seconds of the standard clock.

Quartz clocks have been installed at the Physikalisch-Technischen Reichsanstalt in Germany, and one is now being constructed for the Royal Observatory, Greenwich.

Other uses for piezo-electric quartz have been devised and include direct-reading seismographs in which the gravitational waves impinge on a quartz plate, microphones, and radio gramophone pick-ups, though for these last two applications certain manufacturers at present employ Rochelle Salt.

Sources of Supply

Despite the fact that quartz is so extremely abundant in rocks, veins, lodes and pegmatites, relatively well-crystallised, untwinned specimens are rare, and, as yet, the principal sources of supply are still the Minas Gaeres district in Brazil, and various localities in Madagascar. Efforts are being made, however, to discover Empire supplies, and it is hoped that the measure of success attending future prospecting work will be greater than has yet been attained.

In Brazil the quartz occurs at several localities in the mountainous regions of Cabral, Mineira and Itacambira, in the northern part of Minas Gaeres. Most of the deposits take the form of pegmatites which have been mined principally at Porteiras and Lavrinha west of Diamante, in the Cabral Mountains. Pegmatites are also worked near Santa Rita and Burity do Claudio in the Mineira Range, and a small amount of work has been done in the Itacambira Range, where, however, most of the quartz is water-worn. The mining and transport of quartz from the interior to the railway ceases in December with the commencement of the rainy season, which lasts until March.

Exports of quartz from Brazil under the category rock crystal, shipped principally through Rio de Janeiro, amounted to 230,932 kg. in 1935, 224,476 kg. in 1936, and 155,287 kg. for the first eight months of 1937. By far the largest proportion of the production (about 70 per cent.) is purchased by Japan for fusion purposes, but the first grade larger-size crystals are taken chiefly by the United States for piezo-electrical and optical purposes. The value of the United States quota for the 1937 period averaged $3·17 per kg., whereas that of Japan averaged only $0·05 per kg.

In Madagascar, quartz occurs in many associations in granites, rhyolites and schists, and good specimens have also been obtained from pegmatites, but the bulk of the well-crystallised material is now won from cavities in quartzites found in the mountainous region south-west of Antananarivo. The particular districts in which working is at present being done are around the villages of Ambositra, Ambatofinandrahana, Betafo and Soavinandriana, the first being roughly 110 miles south of the capital of the island, and the last 58 miles west. The total annual production of quartz, including the variety exported as rock-crystal, has varied greatly in recent years, being 128 tons in 1929, 1 ton in 1932, and 16 tons in 1933. The exact proportion of this material which represents piezo-electric quartz, of course, cannot be estimated, but is known to be quite small.

Opencast working is the common method in both Brazil and Madagascar, the quartz-bearing deposits being opened up by hand labour. It is a frequent event for certain buyers' representatives to be in close touch with the mine owners and so obtain first choice of the crystals won.

The search for piezo-electric quartz in the Empire is becoming wider, and localities of some promise have been discovered in India, Uganda, and Tanganyika.

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OIL FROM COAL BY THE FISCHER-TROPSCH PROCESS

THE high degree to which western European nations are dependent upon overseas supplies of petroleum is becoming more and more obvious as both military and civil aircraft development intensifies, the use of motor transport grows, and the trend of marine engine design turns increasingly towards the principle of internal combustion.

In Germany, particularly, the position has been recognised for many years as an acute one, and serious efforts were early directed to preparing suitable motor fuels from coal. Since the hydrogen content of normal coals is considerably below that of even a heavy fuel oil, some means had to be adopted to make good this deficiency. After an immense amount of research had been done, two processes were evolved by which the hydrogen content of coal could be increased and suitable hydrocarbon oils generated.

Of these processes, that depending upon direct hydrogenation of the coal substance, and commonly known after the principal inventor as the Bergius process, has attained a wide measure of publicity which has rather overshadowed the other process, invented by Fischer and Tropsch, whereby motor fuels are prepared by the combination of gases generated from coal. Though the plants now erected for the production of coal oils by the Bergius process outnumber those of the Fischer-Tropsch, more attention is now being directed to the latter.

This process for the production of liquid hydrocarbons by gaseous synthetic methods had its foundations in the very early years of this century. In 1902 Sabatier and Senderens discovered that a reaction between hydrogen and carbon monoxide, previously considered impossible, could be promoted at ordinary pressure by the use of nickel and cobalt catalysts. Work in Germany by the Badische Anilin und Soda Fabrik A.G. some years later, resulted in patents being applied for to cover a process of combining hydrogen and carbon monoxide catalytically, to yield paraffinic hydrocarbons other than methane, and oxygenated derivatives such as alcohols, aldehydes and ketones. In 1923, Dr. Frans Fischer published the results of attempts which had been made at the Kaiser Wilhelm

Institut to produce hydrocarbons by the Badische method using mixtures of hydrogen and carbon monoxide under a pressure of 150 atmospheres and at a temperature between 400° and 450° C., in contact with iron turnings impregnated with potassium carbonate. The synthetic oil which resulted contained about 10 per cent. of organic acids, and was therefore quite unsuitable as a motor fuel or a lubricant. The process though unsuccessful from this point of view gave indications of being of value for the production of alcohols, and was modified to yield methyl alcohol or methanol, a 2 : 1 mixture of hydrogen and carbon monoxide being catalysed with a zinc-chromium compound at about 100 atmospheres and 250° C. The first commercial plant operating this process was erected in 1924 at Leuna with an annual capacity of 35,000 tons of methanol, and has since produced 20,000 to 25,000 tons a year. Other similar plants are now in operation in this country, Belgium, France, the United States and Japan.

The researches of Dr. Fischer and the late Dr. Hans Tropsch in the years 1925 and 1926 at Mülheim revealed that the synthesis would favour the production of methane and the olefine homologues if a temperature lower than the optimum for the production of methane was maintained, and that the efficiency of the catalyst employed could be promoted by the addition of other substances. The best "promoters" for nickel were found to be thoria, alumina, and manganese oxide, and for cobalt, copper oxide and thoria. These substances proved to have the effect of diminishing the susceptibility of the catalyst to sulphur poisoning, and, in conjunction with the hydrogen-carbon monoxide ratio, to influence the rate of reaction and the composition of the end products. In general, the experimenters found that cobalt catalysts give a predominance of relatively unsaturated oils, and nickel catalysts essentially saturated oils.

In 1928 Tropsch left the Institute at Mülheim for Prague, but Koch and Meyer carried on the work of finding other catalysts of sufficiently high reaction velocity, and the highly important problem of desulphurising the raw gases at low cost was solved by Roelen.

For large-scale operations the obvious source of hydrogen and carbon monoxide was blue water-gas, but the high proportion of carbon monoxide present (about 45 per cent.) gave an undue proportion of unsaturated hydrocarbons. To overcome this, coke-oven gas was introduced into the steam blow, roughly in the proportion of 10 cu. ft. of gas to 1 lb. steam, when the issuing gases were found to contain 60 per cent. hydrogen, 30 per cent. carbon monoxide and 10 per cent. nitrogen and other gases. An alternative method of obtaining a 2 : 1 ratio of hydrogen to carbon monoxide is to treat one-third of the water gas with steam when the carbon monoxide reacts in the presence of a catalyst with the steam to form carbon dioxide and hydrogen, the former being removed.

The commercial development of the process in Germany was impeded to a considerable extent by the fact that the Bergius hydrogenation system had been operated commercially since 1927 by the I.G. Farbenindustrie at Leuna. The industrial aspect of the Fischer-Tropsch method, as it was now called, was taken over, however, by Ruhrchemie A.G., who erected a pilot plant in 1933 and later formed a company, Ruhr Benzin A.G., to manufacture 25,000 tons of motor fuel a year at Oberhausen-Holten in the Ruhr.

The industrial process developed consists in passing the synthesis gases from the generators through dust precipitators to a desulphurizing plant. This operates in two stages, the first being concerned with the removal of inorganic sulphur by ordinary gas works' practice, and the second with the catalytic removal of organic sulphur at a temperature of about 200° C. The issuing gases, having a maximum sulphur content of 0·087 gm. per 100 cu. ft., are then cooled and pass to the reaction chambers which have been described as being 5m. long, 120 cm. wide and 22 mm. deep, in which the catalyst, probably a mixture of cobalt salts and thoria, is supported on diatomaceous earth. Since the reaction is strongly exothermic a serious problem has arisen in maintaining the temperature between 190° and 200° C., and a circulation of oil is now commonly used for this purpose. The products of the reaction are cooled to condense the heavier hydrocarbons (known as Kogasin II) and the lighter fractions (Kogasin I) are removed by a scrubbing process or by means of active carbon.

The reacting gases only pass over the catalyst once; in other words re-cycling is not a feature of this process, and the yield consists of gaseous, liquid and solid hydrocarbons. With a nickel catalyst, the products are essentially paraffinoid, though cobalt-base catalysts, as has been mentioned, favour the formation of olefines, and in all cases this tendency can be promoted by lowering the ratio of hydrogen to carbon monoxide. Under normal conditions about 120 gm. of hydrocarbons are obtained per cubic metre of reacting gases, and consist by weight of 8 per cent. of gases, chiefly propane and butane, 60 per cent. of spirit up to 200° C. boiling point, of which 30 to 35 per cent. is olefinic in character, 22 per cent. diesel oil and 10 per cent. solid paraffins. The products which are now separated by vapour-phase distillation have a pleasant odour, are sulphur free, and only require an alkali wash to remove traces of fatty acids. The motor spirit, being paraffinic in character, unfortunately possesses poor anti-knock properties (octane number about 55) and must be blended for normal use, but the diesel oil has a cetene number of 100, and can be blended with inferior oils to give a first-class diesel fuel. In addition a distillate which has good lubricating properties can be obtained from the heavier fractions. The gases stripped of their spirit content are suitable for pyrolysis or polymerisation to high anti-knock spirits; or a proportion may be compressed and sold in containers as a fuel and lighting medium.

After a period which may extend up to 9 or 10 weeks, the catalyst becomes loaded with ceresin wax which may be removed by washing with light petroleum.

Following the successful operation of the Ruhr Benzin A.G. plant, a second concern, Gewerkschaft Rheinpreussen, arranged for a plant of similar capacity to be erected at Homberg, and other plants were ordered by Klöckner-Wintershall, and Braunkohlen Benzin A.G.

The Ruhrchemie A.G. now holds a world licence for the Fischer-Tropsch process, and it was announced at the Düsseldorf Exhibition in 1937 that twelve plants were either in operation or construction in Germany. The total annual capacity of these plants is believed to be 700,000 tons of motor spirit.

Licences have also been taken up in France where a plant is operated at Harnes in the Pas de Calais, by the Société des Produits Courrières Kuhlmann; in Japan and in South Africa.

The relative capital costs of the Fischer-Tropsch and Bergius processes were arrived at by Sir David Rivett, of the Council for Scientific and Industrial Research, Australia, and in 1936 were stated to be (a) for a Bergius plant capable of producing 150,000 tons of petrol annually, approximately £A. 11 million ; and (b) for a Fischer-Tropsch plant capable of yielding 30,000 tons of petrol per year £A. 2·93 million. Since the capital cost of the plant does not increase directly with the capacity, however, it may be assumed that a synthesis installation of output equal to that of a hydrogenation plant would probably not incur an initial outlay of capital greatly in excess of that of the latter. The cost of production per gallon of petrol by the Fischer-Tropsch method appears to be less than that of the Bergius process. (" Oil production, from coal viewed from an Australian standpoint," by Sir David Rivett ; *Rep. to Parliament of the Commonwealth of Australia, Comm. Pap.* No. 71, 1937, p. 17.)

A Fischer-Tropsch plant equal in capacity to the hydrogenation plant at Billingham, which is capable of producing annually 150,000 tons of motor spirit from 500,000 tons of process coal and 100,000 tons of coal for hydrogen and power production, would require annually a quantity of synthetic gases of the order of 300 million cubic metres, or approximately 700,000 tons of coke for the gas generators. This quantity represents some 3 per cent. of the annual coke production of the United Kingdom.

The Sub-Committee of the Committee on Imperial Defence, which reported in February of this year, recommended that a Fischer-Tropsch plant of a capacity between 20,000 and 30,000 tons of primary products per annum might with advantage be erected in the United Kingdom. At present the only activity in this direction is that at the Fuel Research Station, Greenwich, where a laboratory-scale apparatus capable of treating 10 to 15 litres of gas per hour is being operated. The work done so far has revealed the presence of small quantities of aromatic hydrocarbons in the products, and confirmed the claims made for the process by Fischer. The catalyst employed has been cobalt promoted by thoria and supported on diatomaceous earth.

NOTES

Exhibition Galleries.—On Monday, March 28, Her Majesty Queen Mary, accompanied by Their Royal Highnesses the Princesses Elizabeth and Margaret Rose, made a conducted tour of the galleries with the Director and Lady Lindsay, the Curator of the Galleries, and the General Secretary.

Their Majesties the King and Queen have been graciously pleased to loan for exhibition in the Southern Rhodesia Court, coronation gifts received by Their Majesties from the natives of Southern Rhodesia and from Yeta III, Paramount Chief of Barotseland ; for the Australian Court a cabinet of Australian blackwood, a coronation gift from the City of Melbourne ; and for the Fiji Court a whale's-tooth necklace, a gift from a Fijian chieftain. His Majesty The King has also graciously presented for display in the Canadian Court two fine Canadian moose heads, mounted on shields. From Her Majesty Queen Mary has been received a collection of water-colour paintings of scenes in the Dominions for display in the appropriate Courts.

The Exhibition Galleries staff have been actively engaged on work in connection with the preparation and despatch of exhibits for the Colonial Hall and the Burma Pavilion at the Empire Exhibition at Glasgow, and in dealing with enquiries by exhibitors on behalf of Colonial Governments in other sections of the Empire Exhibition.

The following dioramas have been loaned from various Courts for use at Glasgow :—" The Burma Rice Industry " ; " Sir Walter Raleigh discovering the Trinidad Pitch Lake " ; " Freetown Harbour, Sierra Leone," and " The Sierra Leone Piassava industry."

For use in the Burma Pavilion of the Empire Exhibition at Glasgow a new diorama has been made in the Imperial Institute studio by Mr. Herbert Rooke on behalf of the Irrawaddy Flotilla Company. This diorama shows one of the Company's steamers at a calling station on the Irrawaddy, and the scenery of the upper reaches of the river with characteristic temples and shrines. A relief model map of the Irrawaddy area served by the Company has also been made, under the supervision of the Institute's staff, to accompany the diorama, and both map and diorama are ultimately to become available for the new Burma Court which has been installed recently in the Exhibition Galleries. To illustrate some of the uses of Burma teak six small models of the doll's house type have been constructed for use at Glasgow by Mr. Herbert H. Cawood, under the supervision of the Institute's staff. After serving as exhibits in the Burma Pavilion at the Exhibition they also are to be transferred to the Burma Court.

To the Indian Court has been added an exhibit illustrating the production of sugar in India and complementary to the diorama described in the last number of this BULLETIN (p. 61). A series of photographs shows the propagation and the harvesting of the cane. Then follow samples of cane juice and of the various grades of factory sugar produced from the juice, as well as samples of gur or jaggery and of the country-refined sugar. A further section of the exhibit deals with sugar produced from palms. It is hoped to add to this exhibit as further photographs and samples are secured.

Under the heading " Plant versus Insect " an exhibit has been arranged in the Malaya Court to illustrate the use of derris root as an insecticide. Photographs show the propagation, growth and harvesting of *Derris elliptica* in Malaya and the preparation and export of its roots. A sample of the roots and cartons of various insecticide preparations containing derris are also shown.

In the new Sarawak Court photographs and specimens have been arranged to tell the story of mangrove cutch. Starting with the felling of the tree, the photographs show the separation of the bark, its transport to the factory and its initial treatment there. Then follow samples of mangrove bark and of the extract. Applications of the bark extract are represented by a sample of leather tanned with a blend containing cutch, and a specimen of fishing net preserved with it.

To the Seychelles Court have been added models of native pirogues (fishing boats) with their accompanying fishing tackle, and a thatched pirogue shed. They were received for exhibition in the Court from His Excellency the Governor of the Seychelles.

To the Sudan Court has been added an exhibit kindly presented by Messrs. G. E. Cope and Son, of Birmingham, showing the successive stages in the making of pearl buttons from Sudan mother-of-pearl oyster shell and trochus shell. The specimens illustrate the cutting of button blanks, the splitting, turning, drilling, and the final bleaching and polishing of the buttons.

Specimens of woven and bleached cotton cloth made from Sudan cotton received from Messrs. J. and A. Leigh, Ltd., Manchester, through the Advisory Committee in England of the West Indian Sea Island Cotton Association, have been added to the cotton display in the Sudan Court.

From the Chief Inspector of Mines the following specimens of Nigerian minerals have been received for exhibition—diatomite, kyanite, wolfram, columbite, molybdenite and gold.

Specimens of lepidolite, amblygonite, rutile, wolfram and scheelite from South-west Africa received from the Acting Mining Authority, Windhoek, have been added to the collection of South-west African minerals; also samples of Iceland spar and rock garnet presented by Mr. E. E. Beecroft.

A new series of photographs in the East African coffee exhibit, presented by the Coffee Board of Kenya, illustrates the cultivation, harvesting, preparation and transport of coffee. The specimens of East African coffee have also been renewed, and samples of roasted beans and ground beans are now included in the display.

A collection of oxidised and unoxidised gold ores from the Geita Gold Mine, Tanganyika, has been received from the Chief Geologist, Dodoma, through Sir Edmund Teale; and specimens of derris root, ramie fibre, petit grain oil and leaves, twigs and oil of the bitter orange from the Director of Agriculture, Tanganyika Territory. For the new derris exhibit in this Court cartons of derris insecticides have been presented by Messrs. Cooper, McDougall and Robertson, Ltd.

The South African ostrich feathers exhibit has been withdrawn and a new exhibit, kindly lent by Messrs. Balfour and Company, has been installed to illustrate the modern use of bleached and dyed ostrich feathers for making articles of feminine apparel and adornment.

To the Mineral exhibit in the South African Court has been added a range of torbanite specimens comprising the mineral as mined and crude and refined torbanite oils from the South African Torbanite Mining and Refining Co., Ltd.

From the Director, South African Geological Survey, has been received a series of photographs illustrating the quarrying, transport, cutting, polishing and uses of Port St. John's marble; the quarrying of wonderstone; and the mining of gypsum, mica, platinum and copper.

To the exhibit of South African chrome ore have been added further exhibits illustrating the uses of chromium salts in calico-printing and in photography.

To the Fishery exhibit in the Newfoundland Court have been added specimens of cod oil, cod liver oil and seal oil, together with samples of tinned fish received from The Trade Commissioner for Newfoundland.

A new diorama of the Sugar Industry of Fiji has been made in the Imperial Institute studio by Mr. Ernest Whatley to replace one that had become obsolete, and is now installed in the Court. The descriptive label for the diorama reads as follows:—

Fiji

A Sugar Estate and Factory

"This diorama represents a sugar estate and factory at Lautoka, on the coast of Viti Levu, one of the main islands of the Fiji group.

" A few fields of sugar-cane are shown on the left foreground and in the middle distance, with workers engaged in cutting cane and preparing it for transport to the factory. The bulk of the sugar-cane is grown inland and is conveyed to the sugar factory by the estate railway.

" Trainloads of sugar-cane are shown in the factory sidings, whilst at the wharf on the right is a vessel taking in sugar for transport overseas.

" The cultivation of sugar-cane and the production and export of cane sugar on modern lines constitute the main industry of Fiji.

" The bulk of the Fiji output is shipped to the United Kingdom and Canada, whilst molasses are sent to distillers in Australia for the manufacture of industrial alcohol and rum."

The funds for this diorama were generously donated by Sir Philip Goldfinch, K.B.E., of the Colonial Sugar Refining Co., Sydney.

Colonial Visitors.—The following is a list of officers on home leave from the Colonies who have visited the Institute during the three months February to April 1938 :—

FEBRUARY

D. W. H. BAKER, Superintendent of Agriculture, Nigeria.
T. C. CAIRNS, District Agricultural Officer, Tanganyika.
J. DUNDAS, Senior Assistant Conservator of Forests, Nigeria.
W. J. R. MELLOR, Assistant District Officer, Nigeria.

MARCH

Dr. A. L. CRAIG-BENNETT, Chief Fisheries Officer, Palestine.
Prof. F. CREMONA, The University, Malta.
H. W. JACK, M.B.E., Director of Agriculture, Fiji.
N. C. E. MILLER, Acting Senior Entomologist, Department of Agriculture, Straits Settlements and Federated Malay States.
C. C. WEBSTER, Agricultural Officer, Nigeria.

APRIL

C. HARVEY, Agricultural Officer, Tanganyika Territory.
Captain M. C. SINCLAIR, Civil Secretary and District Magistrate, Aden.
H. P. SMART, Agricultural Officer, Tanganyika.

All Dominion and Colonial officers, as well as private residents overseas, who may be visiting London are cordially invited to come to the Institute to see our Exhibition Galleries, and to discuss scientific and technical problems in which they may be interested.

Ephedra.—Although the drug Ephedra has been known to the Chinese for thousands of years its introduction into Western medicine for the treatment of asthma and hay fever is quite a recent step. The drug consists of the dried stems of certain species of *Ephedra*, small shrubby plants, the shoots of which somewhat resemble in appearance the common "horse tails," although quite distinct botanically. The value of these stems depends on their content of the alkaloid ephedrine and its isomeric form pseudoephedrine; other alkaloids are often present as well, but these apparently have no medicinal value.

Plants of the genus *Ephedra* occur in many of the warm dry regions of the world, but the species containing sufficient quantities of ephedrine or pseudoephedrine to be of commercial importance are few, and somewhat restricted in their geographical distribution. Although plants from Europe and Northern India have been used, by far the greatest part of the world's supply of the drug comes from China. Three species only enter into commerce to any large extent, namely *E. sinica* Stapf, *E. equisetina* Bunge and *E. distachya* L., all of which are sold on the Chinese markets under the name Ma-huang. The bulk of the commercial material is *E. sinica* or Tsaopen Ma-huang, which together with *E. equisetina* (Mupen Ma-huang) is collected among the T'ai-hong-shan mountains running southwards between the provinces of Chihli and Shansi. The third species, *E. distachya*, is gathered in Central China, from Shansi to Honan and Hupeh, and appears on the Yangtze markets. Information regarding the wider distribution of these plants is difficult to obtain, but it is stated that *E. sinica* occurs in Thibet, while *E. distachya* is reported from Europe. It is said that the European material of this species gives a good yield of pseudoephedrine, though plants of *E. distachya* from Asia are characterised by a relatively higher content of ephedrine.

Five species are stated to occur in India, chiefly at high altitudes in the mountains of Baluchistan and the Himalayas, while two of them have been recorded also from Western China. In investigations of Indian Ephedras which have been carried out by Krishna and Ghose (*Indian Forest Records*, 1930, Vol. 16, II) very promising results were obtained from analyses of two closely allied species, *E. nebrodensis* Tineo and *E. Gerardiana* Wall. These proved in some cases to contain a higher proportion of ephedrine than *E. sinica* from China; indeed, one sample of *E. nebrodensis* from Lahoul yielded 1·93 per cent. of ephedrine, which far surpasses the content of the average Chinese material. It must be noted, however, that plants of the same species from different localities were found to vary considerably in alkaloid content.

Outside China and India various species grow in Persia, Arabia, Somaliland, Europe and the Mediterranean region. So far as can be traced from the literature available at the Imperial Institute only three of these, namely *E. vulgaris* var. *helvetica*, *E. distachya* and *E. alata*, have been found to contain any useful alkaloid. The first is said to form the source of the

European material. Little information is available about *E. distachya* outside China, but *E. alata* is of particular interest as a possible new source of the drug, for a sample from Morocco was found to contain as much as 1 per cent. of pseudoephedrine. The plant is known to occur also in Arabia, but there appear to be no published analyses of material from that country.

Of the New World species, those growing in the United States contain no useful alkaloids, and little is known of the South American representatives.

The distribution of Ephedra is strictly limited to arid regions, and it may be generalised that the useful species require also a relatively high altitude (the Indian species occur up to 16,000 ft.) and correspondingly cool climatic conditions. Whereas the alkaloid content of the Chinese species is said to be greatly affected by altitude, Krishna and Ghose (*loc. cit.*) found that the influence of rainfall plays a much more important part in the case of the Indian Ephedras, a high content of ephedrine being associated with a low rainfall, while even a single heavy rain-shower will bring about a temporary reduction in alkaloids. Thus rainfall may have a modifying effect on the general seasonal trend of the alkaloid content, which is said normally to show a steady increase through the summer months, reaching a maximum in the autumn. In spite of the effect of local climate, however, it is still generally true that the ephedrine content is highest in the autumn, and it is customary for the Chinese to harvest the stems at this season.

It has already been mentioned that practically the whole of the world's supply of Ephedra comes from China. This source has been largely cut off as a result of the war, and it is doubtful to what extent the 1937 crop has been gathered. The same is true also of Spain, which formerly produced small quantities of the drug. Towards the end of 1937 the market situation was becoming serious, as the existing stocks were extremely low, and there was no immediate prospect of further shipments. The price of ephedrine hydrochloride in bulk quantities, which at the end of July had been about 5*s*. per oz., had reached over 20*s*. per oz. by November, and quotations for the pure alkaloid had similarly risen from 6*s*. to 25*s*. per oz. The beginning of 1938 saw a slight falling off in price to 15*s*. per oz. for the hydrochloride and 20*s*. for the pure alkaloid, whilst by May the price had fallen still further to 8*s*.–9*s*. per oz. for the former, and 12*s*. 6*d*. per oz. for the latter. Fresh supplies of the crude drug have been received in small quantities, and in April 1938, the herb was quoted at about 39*s*. per cwt., c.i.f., for June shipment. The improvement in the position is said to be mainly due to the introduction on the market of synthetic ephedrine hydrochloride, which it is claimed complies with the British Pharmacopœia Specification. It is understood, however, that the cost of production of the synthetic drug is much more than the normal market value of the natural product, and that its position on the market is therefore not likely to be maintained. The normal demand for the drug has increased very considerably in recent years, and further increases are likely as its use in medicine becomes more general.

Attention has naturally been drawn to the possibility of producing the drug in Empire countries, either by exploiting any naturally occurring species or by introducing the Chinese material into cultivation.

Various species of Ephedra do grow wild in such countries as Cyprus, Palestine and British Somaliland, but their value remains as yet unexplored. In view of the work of Krishna and Ghose referred to above, India appears promising as a possible source of the drug, and it is urged that efforts should be made to develop trade in the Indian Ephedras. So far there is not a great deal of information available regarding the quantities in which material of high ephedrine content could be supplied from India. It is worth noting, however, that, as long ago as 1928, 34 tons of the drug were shipped to the United States, whilst it is recorded that during March, 1938, two consignments, aggregating nearly 80 tons, reached that country from India.

Among the Empire countries where the Chinese species of Ephedra might be introduced Kenya has been suggested as a possibility, and it is understood that trials have just been started there with material supplied from Kew. It will be interesting to see whether the plants will thrive and give a good yield of alkaloid under the conditions obtaining in that Colony.

Details of the plant's cultural requirements and adaptability to new soil and climatic conditions are very little known. Various species have been cultivated in England, both at Kew and elsewhere, but in all cases growth was extremely slow and the alkaloid content far too low to be of any value. Trials carried out in the United States by Christensen and Hiner, in South Dakota, proved more successful; these are fully described in the *Journal of the American Pharmaceutical Association*, Vol. 25, 1936, pp. 969-73. Seed of *E. sinica*, obtained from Peking Union Medical College, was planted in 1929, and showed excellent germination within a fortnight. Plants from the first lot of seed were reared in a greenhouse, but it was later found that the plants were hardy and would reproduce readily from seed in the open. The young plants were cultivated in nursery beds for at least two years before planting out in the field. Propagation from suckers also presented no difficulty, and it is stated that the new plants transplant well by severing them from the old root and allowing them to remain undisturbed for about three weeks before moving to their new location.

The best time for harvesting was found to be late autumn, before the first frost. The crop was simply mown in the ordinary way and allowed to cure in the field, like hay; this gave better results than oven-curing. Although the plants were large enough to cut after two years, it was found better not to harvest too soon as the alkaloid content of the young shoots is very low. Even in older plants which had been cut the previous year the new stems of one year's growth contained little ephedrine. The stems proved winter-hardy under South Dakota conditions, although blackening somewhat, and those of two years' growth yielded up to 0·36 per cent. of ephedrine.

The climate in South Dakota, where the plants were grown is rather dry and sunny, with very cold winters. The average summer temperature is given as about 70° F., while the winter average is below 20° F., with minimum temperatures below – 30° F. and sometimes more than 60 days in the year when the temperature does not rise above freezing all day. The summer growing period, free from severe frosts, is from early May to late September, on an average about 130 days. There were two regions where the Ephedra was grown—one between 2,000 and 4,000 ft. altitude, with an annual rainfall of less than 15 in., the other below 2,000 ft., having a rainfall of about 25 in. In both cases the rain comes almost entirely in the summer.

New Industrial Uses for Silver.—Some time ago a research project, sponsored by a group of leading American silver producers, was initiated for the purpose of investigating thoroughly all aspects of the silver industry. Research along different lines is being carried on at various centres, the work including investigations into the bactericidal, chemical, fungicidal, physico-chemical and thermal properties of silver, as well as its electrical characteristics and metallurgical possibilities.

The success which has attended the venture may be judged from the first series of results published in the *Journal of the Franklin Institute*, 1938, **225**, No. 2, 227-229. The results show that progress has been made which may be of definite value to the silver industry.

A very profitable line of research has been that dealing with the anti-friction properties of silver and silver alloys. Pure silver gave very good results. Steel-backed bearings lined with nearly pure silver are finding an increasing use in industry and have been, in fact, adopted as standard equipment in certain aeroplane engine parts.

Experiments have also led to the development of better adhering methods for the electro-deposition of silver on steel and to an improvement in technique for the co-deposition of a number of elements with silver.

For rotating electrical contacts silver slip-rings and silver-graphite brushes have been found more effective than those of carbon and copper-graphite ; the contact voltage drop is appreciably decreased and there is less polarity effect.

The value of silver salts as fungicides has been proved and certain salts have also been used with success in water sterilization, particularly in fish hatcheries.

The permeability of hot silver to oxygen has also been investigated and results have shown that this property may be employed successfully in air fractionation, as, for example, in the enrichment of blast furnace air. The solubility of oxygen in molten silver has also been studied.

As a catalyst in the oxidation of ethyl alcohol silver has given very satisfactory results.

Research is proceeding along a number of other lines and results are to be made public as they become available.

Canadian Nickel.—The November 1937 issue of the *Canadian Mining Journal* was devoted almost entirely to a 165-page account of the operations and plants of the International Nickel Company of Canada, compiled by the executive and operating staffs of that company. This is a comprehensive, authoritative and lavishly illustrated document which for some time will doubtless remain the standard work on the subject.

It describes the operations carried out in Canada, in the United States and in the United Kingdom, and lastly it contains a general section dealing in the main with distribution and the search for markets.

The Canadian section deals with geology and mining, passing thence to milling, smelting, copper refining, nickel refining, power, and concluding with an account of accident prevention both in the mines and at surface plant.

Although intensive study and research have served only to intensify the controversy as to the genesis of the Sudbury nickel ores, much has been learned thereby concerning structure and the degree of its control on the localization of ore. Early in 1931 the company organised a department for geological research, the work of which is entering its final stages. The results of the special research of recent years are not indicated but an attempt is made to clarify the classifications, correlation and nomenclature applied to the various formations, and this is accompanied by a valuable detailed table. It is also interesting to note that in the course of the last six years the entire norite contact and a belt of the adjacent rocks have been mapped in detail on a scale of one inch to 200 feet.

The chapter on mining deals with the work of the mines engineering department, its general routine, methods of surveying, sampling, and estimation of reserves, passing to detailed descriptions of the Frood, Creighton, Garson, and Levack mines, including their lay-out, equipment and method of working. The chapters on milling, smelting, copper refining, and nickel refining provide a valuable account of the processes employed. Descriptions of the rolling mill at the Huntington works, Huntington, W. Virginia, and the foundry at Bayonne, New Jersey, form the section entitled "American Operations."

Monel metal, discovered in 1906, was the outcome of a desire to produce metal direct from Creighton mine ore without separating the nickel from copper. In the Creighton ore-body nickel and copper are present in approximately the ratio 2 : 1, and it is interesting to note that, in the modern monel, which is still produced from Creighton ore, the same ratio still obtains. By 1921 the demand for monel had reached a point where it became desirable for the company to erect its own fabricating plant at Huntington. An important factor influencing the choice of that locality was the abundance of cheap, sulphur-free natural gas in southern West Virginia, for sulphur in fuel is a handicap in the production of pure nickel, monel, and other high-nickel alloys. In addition to monel, the Huntington works produce and roll " Inconel " and other high-nickel alloys. The foundry at Bayonne produces nickel, monel and " Inconel " sand castings, and numerous other products for sale to outside foundries.

Of particular interest is the account of the activities in the United Kingdom of the numerous ramifications of The Mond Nickel Company, now an integral part of The International Nickel Company. These include the Clydach refinery and Tareni colliery in Wales, the Henry Wiggin organisation, the precious metals refinery at Acton, and research and development activities.

Ever since the discovery of the Mond carbonyl process forty years ago an important part of the nickel producing industry has been located in this country. For many years a Bessemer matte containing about 35 to 40 per cent. of nickel and 40 to 45 per cent. of copper was sent from Canada to Clydach, near Swansea, for the production of nickel by the carbonyl process. It was necessary first to extract the copper, and this was done, after calcination, by means of an acid leaching process which led to the production of copper sulphate. The residue was then treated by the carbonyl process. The erection of tariff barriers, however, led to unsatisfactory market conditions for copper sulphate. Moreover, International Nickel had built its own copper refinery at Copper Cliff, Ontario. So in 1930 the procedure at Clydach was altered to permit the use of washed nickel sulphide. This material, which is imported from Port Colborne, Ontario, in the partly calcined condition so that it contains only five to eight per cent. of sulphur, contains in addition a little copper and the bulk of the platinum metals, though the greater part of the gold and silver have followed the copper in the main copper-nickel separation. This change in the basic procedure entailed considerable alterations to plant and equipment at Clydach.

In order to manufacture the large quantities of producer gas and water gas required by the carbonyl process at Clydach a subsidiary company was formed to work the neighbouring Tareni colliery, thus ensuring a regular and reliable supply of a suitable quality of anthracite.

The production of nickel, monel and other nickel alloys in the form of malleable products for markets other than Canada is carried out in the plants of Henry Wiggin & Co., Ltd. This organisation consists of rolling mills at Birmingham and extrusion and tube works at Glasgow. The raw materials in both instances are nickel pellets from Clydach, copper from the Ontario Refining Company at Copper Cliff, and monel slabs, billets and bars from the Huntington Works in West Virginia.

The residues containing platinum metals, gold and silver obtained at the nickel refinery at Clydach are sent to a special precious metals refinery at Acton, London. Since 1927, when International Nickel and Mond Nickel were amalgamated, the platinum-metal residues from the electrolytic-nickel refinery at Port Colborne and from the electrolytic-copper refinery at Copper Cliff have also been sent to Acton for treatment. Built in 1924, the works were designed to handle only 30,000 troy ounces of the platinum-metals annually, but by 1936 production had risen to 232,000 ounces. As a result, Acton is now the world's largest platinum-metals refinery and is estimated to be supplying over half of the world consumption of these metals. The processes used at Acton are necessarily intricate as platinum, palladium, rhodium, ruthenium, iridium, osmium, gold and silver have to be separated, not only from one another, but also from the base metals contained in the raw concentrates. The efficiency of this plant is indicated by the fact that the average purity of the metals recovered is: platinum, 99·93 per cent.; palladium, 99·94 per cent.; rhodium, 99·7 per cent.; ruthenium, 99·7 per cent.; iridium, 99·7 per cent.; gold, 99·97 per cent.; silver, 99·97 per cent.

The concluding pages tell a romantic story of the search for markets, and the increasing number of applications, until at the present day over 2,300 of the 8,200 alloys recognised by the world metal markets contain nickel.

The Outokumpu Copper Mine and Smelter, Finland.—The largest known deposit of copper ore in Europe, excluding the Soviet Union, is at Outokumpu, in eastern Finland, where 20 million tons of ore, containing 800,000 tons of copper, have been proved by systematic drilling over a distance of roughly two miles. The occurrence was located in 1910 by a geologist attached to the Geological Survey of Finland, who traced various glacial ore boulders for approximately 30 miles to their source. A joint stock company, owned largely by the Finnish State, was subsequently formed, and a pilot plant was erected with a capacity of 10,000 metric tons of ore per annum. Production of ore began in 1913 and has continued at an increasing rate to the present day, the mill being rebuilt in 1928 and re-designed by C. G. McLachlan, concentrator superintendent to Noranda Mines, Ltd., Canada, in 1937. Production of electrolytic copper also began in 1913 and continued until 1929, when the plant was dismantled. Later, an up-to-date smelter, incorporating many novel features and designed by Mr. Vestly, head of the Sulitelma copper mine in Norway, was erected at Imatra, in Southern Finland.

In 1937 the company's production was estimated at 11,000 to 12,000 metric tons of crude copper, 150 kg. of gold, 1,800 kg. of silver, 60,000 metric tons of sulphur in sulphur dioxide, and 65,000 to 70,000 metric tons of pyrite cinder. The ore body should last for at least 50 years at the present rate of operation.

The production of ore since 1913 is shown in the following table:

	Metric tons.
1913 to 1927	217,000
1928	35,000
1929	102,000
1930	127,000
1931	156,000
1932	158,000
1933	173,000
1934	275,000
1935	352,000
1936	369,000

A detailed account of the mining, milling and smelting methods employed by the Outokumpu Copper Company, together with much other valuable information, has recently been given by the General Manager, Mr. Eero Mäkinen, in *Mining and Metallurgy* for February 1938, pp. 85-91, from which the present note has been compiled.

According to this authority the mineralogical and chemical composition of the ore, which occurs in a brecciated pre-Cambrian quartzite, is as follows :—

Composition of Ore

Mineralogical.	Per cent.	Chemical.	Per cent.
Chalcopyrite .	11 to 12	Copper . .	4·0
Pyrite	30	Zinc . .	0·8
Pyrrhotite	15 to 16	Iron . .	26·0
Sphalerite	1	Sulphur .	25·0
Quartz .	42	Silica . .	42·0
		Cobalt . .	0·2
		Nickel . .	0·1
		Arsenic . .	0·01
		Selenium .	0·001
		Antimony .	Nil
		Bismuth .	Nil
		Gold . .	*0·8 oz. per ton*
		Silver . .	*12 oz. per ton*

The ore is won, for the most part, by shrinkage stoping, and, after grinding in ball mills to about 100 mesh, is concentrated by differential flotation to yield a copper concentrate and a pyrite concentrate as tailing. The pyrite concentrate is sold to local sulphite pulp mills which extract the sulphur dioxide and return the cinders, amounting to about 70,000 tons yearly, to a newly-built steelworks owned by the joint stock company, and situated alongside the copper smelter at Imatra. The copper concentrate is smelted in a vertical electric furnace, lined with magnesite bricks, to yield a matte containing 38 to 45 per cent. copper, which is blown in horizontal converters to blister copper containing 99 per cent. of copper in addition to 12 grams of gold, and 150 grams of silver per ton of copper. The blister copper is exported for refining. During the smelting operation the sulphur dioxide is recovered in liquid form by a recently constructed plant designed by Imperial Chemical Industries, Ltd.

The cost, in cents per pound of blister copper produced, is itemized below :

	Cents per lb.
Mining	1·27
Concentrating	1·25
Freight for concentrates	0·84
Smelting	1·45
Overhead cost, including interest and taxes . .	1·68
Depreciation and depletion	1·21
Total	7·70
Less income from by-products : sulphur in different forms, iron cinder, gold and silver . . .	2·80
Net cost of blister copper .	4·90

The Radium Deposits at Great Bear Lake.—These world-famous deposits have been the subject of a previous note in this BULLETIN, 1937, **35**, 211, but some more specific information is contained in several recent papers by the Staff of Eldorado Gold Mines, Ltd. (*Canad. Min. Metall. Bull.*, 1938, No. 310, 61-76).

The property owned by the Company consists of 51 claims on the north-east shore of Great Bear Lake, a heavily glaciated region covered by stunted vegetation which nevertheless has provided sufficient timber for all mining purposes.

Geologically, the area is part of the pre-Cambrian Canadian Shield and is largely composed of highly altered sediments characterised by irregular segregations of biotite and actinolite, bands of reddish jasper and chert, and both banded and disseminated pyrite. Igneous activity has been very pronounced in the region, and along the east shore of the Lake an extensive intrusion of granite exists from which aplitic sills and dykes have been formed.

In addition there are several areas of tuffs, andesites and other volcanic rocks, and many outcrops of basic intrusive rocks which occur as sills and laccoliths, often displaying columnar structure. Certain observers believe that the Eldorado mineralization may be related to this suite, but mining has so far provided little supporting evidence for this theory.

At a later stage of the intrusion of the granite, a series of major fractures, clearly visible from the air, were developed striking roughly north-east and dipping to the north-west, which intersect the aplite dykes. These fractures have provided the channels for the mineralising solutions which appeared in three phases, the first being a deposition of large masses of magnetite near the veins, and a widespread dissemination of pyrite; the second a pitchblende-quartz-carbonate mineralisation; and the last phase, of carbonate, lead, copper and silver minerals.

The economic minerals are the early deposited pitchblende, and the late-formed native silver and chalcopyrite, but at depth the veins show increasing amounts of cobalt-nickel minerals and native bismuth, which may subsequently assume economic importance. The gangue minerals are principally quartz and jasper which are associated with the pitchblende; and the carbonates, calcite, dolomite and rhodochrosite in which the bulk of the silver is found. The pitchblende occurs mostly in massive or botryoidal form as lenses and stringers 3 in. to 18 in. wide, and, when pure, has a jet black colour; while the silver is almost wholly native, occurring as wires, leaves and dendritic growths.

Intensive surface alteration of the veins has taken place resulting in a striking development of uranium minerals which are found as light green, orange and canary yellow stains and incrustations in the gossans and thus form a most valuable guide to prospectors. Soot-black manganese minerals and the characteristic green and blue alteration products of the copper sulphides are also prevalent.

The particular veins on which attention has been concentrated are three in number, striking N. 57° E., dipping 65° to 80° to the north-west, and apparently converging to the north-east. They persist for at least 4,000 ft. along the strike, have a width of from 4 ft. to 10 ft., and the lowest level reached as yet, at 500 ft., shows no serious decline in pitchblende values.

Mining, in a locality where winter temperatures fall below −40° F. and the limit of the frost zone is found to be 320 ft. below the surface, has necessitated special precautions to keep drilling machines, water pipes, haulage ways and ditches free from ice; and above the frost level even the broken ore freezes, necessitating much reblasting. In sinking the vertical two-compartment shaft the drill holes were prevented from freezing by means of salt, and in driving the adit level hot water was used in the drilling operations.

Including the adit there are five levels in the mine, at 125 ft. intervals, and the ore is won by ordinary shrinkage stoping. High-grade ore is hand-sorted in the stopes whenever possible and sent direct to the concentrator to be bagged for shipment.

High transport charges ($110 per ton for water-borne freight) render it essential to ship only high-grade concentrates. The difficulties in devising a satisfactory concentrating process have been considerable, but a large measure of success has now been achieved and the milling process, which includes two flotation circuits, now recovers 48 per cent. of the pitchblende, amounting to 678·37 oz. per ton of ore.

According to a Canadian *Press Bulletin* issued on April 12, 1938, 46 tons of ore are reduced at the mill to 1 ton of pitchblende concentrate which, in turn, at the refinery at Port Hope yields $\frac{1}{10}$ gram radium, 700 lb. uranium products, and from 1,000 to 1,300 oz. silver.

The production at this refinery, which in its extended form now has a capacity of 108 gm. of radium a year, has been as follows:—

	Concentrates Treated.	Radium Production.	Uranium Products.	Silver.
	Tons.	*mg.*	*lb.*	*oz.*
1933	59	3,021	34,940	
1934	26	2,820	27,748	30,052
1935	116	8,486	73,089	111,902
1936	242	15,541·35	160,662	217,907
1937	290	23,770·14	211,857	135,442*
1938†	840	70,000	546,000	600,000

* *Decrease due to change in milling practice, silver going into silver-copper concentrates.*

† *Estimated figures.*

Zirconium.—Although it was discovered more than a century ago zirconium has become a metal of economic importance only within the past 25 years. The rise to importance of this and of some of the other lesser-known metals is described in an article entitled " Economics of Some of the Less Familiar Elements " by H. Conrad Meyer (*Industr. Engng. Chem., Industr. Ed.*, 1938, **30**, 431-436).

Owing possibly to its limited applications, it is not perhaps generally realised that zirconium ranks nineteenth in order of abundance of elements in the earth's crust, being two and a half times as plentiful as copper and thirteen times as abundant as lead.

There are two commercially important sources of zirconium: zircon, a silicate, and baddeleyite, a natural oxide which occurs in an impure form as zirkite. Zircon, the more abundant, is found in beach deposits in various parts of the world, where the sands have probably been formed as the result of the denudation of granites, gneisses and pegmatites containing zircon as an accessory mineral.

Australia, India and Brazil provide the bulk of the world's supplies of industrial zircon. The zircon content of the Australian beach sands ranges from 40 to 75 per cent., the mineral being separated magnetically and by flotation from the associated ilmenite and rutile. The Indian deposits on the Travancore coast are worked for ilmenite and monazite in addition to zircon, ilmenite being now the most important product. Probably the oldest commercial source of zircon is, however, Brazil, where the beach sands along a coastal strip extending from Rio de Janeiro to Bahia contain about 20 per cent. of zircon in the mixed concentrates.

Brazil is at present the only source of the oxide, baddeleyite, extensive deposits occurring in the vicinity of Poços de Caldas. The district is notable for the presence of highly mineralised hot springs which are thought to have played an important part in the formation of the zirconium oxide.

In the issue of *Foote-Prints* for December 1937, J. D. Fast has contributed an article on " Zirconium " in which he deals with the results arrived at by various investigators over the last seven or eight years with reference to the metal and its compounds.

Zirconium dioxide is the most commonly used zirconium compound, its chief use being probably as an opacifier for glazes and enamels. On account of its low coefficient of thermal expansion, its chemical inertness and its high melting point of about 2700° C., it is also used as a refractory. Complications are introduced, however, owing to the fact that the oxide undergoes several changes in crystal form on firing. Consequently, the pure unfused oxide is considered to be unsuitable for the manufacture of super-refractories, but there are two methods of making serviceable refractories from it. In one of these the oxide is previously melted, when a stable modification may be formed; in the other the oxide, mixed with a few per cent. of magnesium oxide, is previously fired to a minimum temperature of 1700° C., thus causing a stable cubic lattice to be formed. The thermal properties are, however, greatly impaired by the addition of the magnesium oxide, as it causes the emission of fumes and the lowering of the melting point, and such refractories are unsuitable for use at temperatures exceeding 2000° C.

The use of zirconia as a refractory, however, has not been extensively developed on account of the difficulty of competing with cheaper refractory minerals such as chromite and magnesite.

Its use as an opacifier is based on its slight solubility in glass, a property which is, to a large extent, dependent on the kind and amount of other constituents present. In comparatively small quantities it can be used in the glass industry for the improvement of various kinds of glass by increasing the chemical durability and improving the mechanical qualities. At present large quantities of the oxide are being used in the United States as an opacifier in enamelled metal ware and it offers great possibilities in connection with the manufacture of entirely new types of glass and porcelain.

Zirconium metal was for a long time regarded as being only of academic interest. Recent developments in methods of production have, however, helped to put the metal on the market in commercial quantities. The most important characteristic of metallic zirconium is its chemical activity which exceeds that of its related element, titanium. It may be obtained in two forms, either as finely divided zirconium metal powder or as ductile zirconium (in wire, sheets, rods, etc.). The application of the powder, sold as a finely divided black powder, is based on its high heat of combustion and its relatively low ignition temperature. It is used as an igniter in photoflash bulbs and in primer compositions for ammunition. When mixed with oxidising substances such as barium nitrate or potassium chlorate it makes an excellent smokeless flashlight powder which is claimed to be superior to magnesium metal powder.

Ductile zirconium, made by the thermal decomposition of zirconium iodide, is prepared in the form of rods which can be readily reduced to wire and sheets. It is used, for example, in discharge tubes, and in the case of transmitting valves serves three different purposes. Its uses as a " getter " and as a means of preventing the emission of secondary electrons through the grid are often combined, the grid itself being made of zirconium wire, or of a wire having a base of other metal covered with zirconium. Its third use is for spot-welding components made of tungsten or molybdenum. Ductile zirconium metal, however, is still relatively expensive, and it is being manufactured only on a small scale.

Zirconium, in the form of various alloys, is used in metallurgy as a deoxidiser and a scavenger, full use being made of its strong affinity for oxygen and nitrogen. In recent years there has also been a growing interest in its use as an alloy and this has helped to maintain the demand for baddeleyite as practically all ferro-zirconium is produced from the natural oxide. In addition to its use in ferro-alloys, zirconium forms alloys with a number of other metals, notably copper, and such an alloy, containing 14 to 16 per cent. of zirconium metal, is competing seriously with similar beryllium-copper alloys. This application will probably show the same development as in the case of the related element titanium.

Olivine and Forsterite Refractories.—The introduction of olivine to the field of industrial minerals, by the manufacture from it of forsterite refractories, is a development worthy of notice, as the commercial use of this mineral has hitherto been confined to its employment as a gemstone. A note on forsterite refractories appeared in this BULLETIN, 1936, **34**, 88.

The olivines are igneous in origin and are believed to be among the first minerals formed from the molten magma. Their separation from later crystallising minerals may be very definite, so that deposits are sometimes found which consist almost entirely of olivine. Igneous rock consisting of olivine is called dunite, and it is from this that a modern high temperature refractory has been developed [F. A. Harvey and R. E. Birch, *Industr. Engng. Chem.* (*Industr. Ed.*) 1938, **30**, 27, and V. M. Goldschmidt, *ibid*, 32].

The dunite as mined may contain up to 85 per cent. forsterite, but the accessory minerals are mostly of low refractoriness, and for this reason high temperature refractories cannot be made direct from the quarried mineral. The present method of manufacture consists essentially of heating the crushed natural rock with magnesia so as to convert the major impurities into material at least as refractory as the forsteritic olivine particles of which the rock is largely composed. Thus, enstatite and serpentine are converted into forsterite, while any ferric oxide present in the natural rock, or formed in firing, combines with the added magnesia to form magnesioferrite. The properties of forsterite bricks manufactured from material prepared as above may be summarised as follows:—

(1) Their softening point is above 1850° C.

(2) Linear shrinkage is about 0·0 to 0·5 per cent. when heated to a temperature of 1650° C. for 5 hours.

(3) Their cold crushing strength is about 2500 lb. per sq. in. In the A.S.T.M. hot load test the bricks will withstand a load of 25 lb. per sq. in. at a temperature of 1570° C.

(4) Their thermal conductivity is lower than that of silica bricks.

(5) They are more resistant to spalling than ordinary magnesite bricks.

(6) Their thermal expansion is of the same order as, but lower than, that of magnesite bricks. The expansion rate is uniform.

Forsterite refractories have shown excellent properties in certain fields of application, e.g. in ceramic kilns, in certain induction furnaces, in the arched roofs of copper smelting and refining furnaces, and in the hearths of forging and reheating furnaces. Other likely uses, such as in the linings of rotary cement kilns, are still in the experimental stage.

It is stated that the comparatively low resistance of present-day forsterite bricks to the action of metallurgical slags (other than those very rich in iron) has been improved by the adoption of an improved method of manufacture. Increased resistance to spalling has been obtained by making the bricks from two different components: (*a*) the granular refractory substance olivine, and (*b*) a cementing material, which may be made from a finely ground spinel mineral rich in magnesium and chromium, and can be added in proportions up to 30 per cent.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

SOILS

Nigeria.—The following statement is furnished in the half-yearly report of the Chemical Section at Ibadan, Southern Provinces, Nigeria (July-December 1937), by H. C. Doyne, Senior Chemist.

Mention has been made before of an attempt to find out the changes which occur on a soil which is kept entirely free from growth of any sort and which is cultivated weekly.

Three such plots have been in existence since June 1934 and composite samples are taken from each to a depth of 6 in. every month.

After three years it was found that there was an average loss of 43 per cent. of total nitrogen (initially 0·046 per cent.) and 39 per cent. of total exchangeable bases (initially 3·38 Mil. Equivs. per cent.). The Carbon-Nitrogen ratio had increased by 3 per cent. (11·5 to 11·9) and the *p*H value had dropped from 6·6 — 6·3 to 6·3 — 5·9. There was no apparent change in available phosphorus content. The plots were on poor sandy soil on which the surrounding vegetation is spear-grass.

Owing to the level nature of the ground and the small size of the plots, erosion is unlikely to have occurred, and the silt with clay content had not diminished two years after the experiment had started.

The experiment is being continued.

Palestine.—The following account of the results of investigations carried out in the laboratory of the Health Department is taken from a report on agricultural research work conducted in Palestine during the half-year ended December 31, 1937, which has been furnished by the Colonial Secretary.

The Relation between Exchangeable Cations and Active Aluminium.—For this purpose soil samples were submitted from Attarot, near Jerusalem, and from the area Asharon, near Petah-Tiqvah. From the analytical data obtained the following conclusions have been reached :—

(*a*) That a close relation exists between the position and valency of absorbed cation and the amount of active Al_2O_3 in soil. The saturation state with cations influences the weathering, and both of these have their effect on the appearance of toxic "Al_2O_3."

(*b*) Soils containing active Al_2O_3 can be improved by adding K and Ca salts, while on the other hand, Li and Mg salts increase the active aluminium toxicity of soil.

(*c*) The maximum of active Al_2O_3 was found in H-soil.

A paper on this subject, written by F. Menchikowski and M. Puffeles, has been accepted for publication in " Soil-Science."

The Influence of Neutral Salts on the pH of Soils.—Experiments on this subject have been continued, by preparing artificial soil with Ca, Mg, K and Na, in the absorbing complex of the soil. From the analytical data obtained it is concluded that Ca-soil is more resistant to the effect of neutral salt in lowering the *p*H than Mg-soil, and K-soil is more resistant than Na-soil. A paper on this problem has been submitted for publication by M. Puffeles.

MANURES

Nigeria.—Mr. W. A. Watson, Agricultural Chemist, in his account of work carried out by the Chemical Section, Northern Provinces, during the half-year July-December 1937, reports as follows:

Permanent Manurial Experiment.—A permanent manurial experiment was started on Samaru farm. Farmyard manure at the rate of two tons per acre is being compared with the mineral equivalent in that amount of farmyard manure of—

(*a*) P (as superphosphate),
(*b*) PK (K as K_2SO_4),
(*c*) NPK (N as $NaNO_3$).

In recent years it has been established beyond reasonable doubt that the notable response of grain crops to small dressings of farmyard manure is in large part due to its phosphate content. Roughly the increased yield resulting from two tons farmyard manure per acre was equal to that of phosphate equivalent to two tons farmyard manure. Nitrogen *per se* has little effect in grain yield and only when combined with heavier phosphate dressings does it appear beneficial. Rather surprisingly potassium has been found to have no effect by itself or in combination.

The experiment under review has been laid down to note whether over a period of years the lack of organic matter in the mineral dressings would affect the yield or the physical proportion of the soil. It would also be apparent whether in the absence of nitrogen and potassium, dressings of superphosphate alone will continue to be as effective.

The experiment is being conducted according to Faulkner's strip method with ⅛-acre plots and four replications.

The results for the first year show that the NPK treatment has given a non-significant increase over farmyard manure amounting to 17 per cent.

The P and PK treatments gave slight but non-significant increases.

The test crop used was a bulrush millet.

Availability of Ground Rock Phosphate.—An experiment was conducted bearing on the possibility of increasing the availability of ground rock phosphate by adding it to the pen in small quantities during the making of farmyard manure throughout a whole year. It was thought just possible that the long continued contact of the phosphate with the manure might increase its availability. As a comparison, an equal weight of ground rock phosphate added to the manure was approximately equivalent to the phosphoric acid in 8 tons farmyard manure. The manure was applied at the rate of

2 tons per acre. A control treatment of ordinary farmyard manure at 2 tons per acre was included.

There were thus two treatments and a control:—

(1) Rock phosphate equivalent to phosphoric acid in 8 tons farmyard manure added to 2 tons farmyard manure during making T1

(2) Rock phosphate equivalent to phosphoric acid in 8 tons farmyard manure added to 2 tons farmyard manure at time of carting T2

(C) "Control" of 2 tons per acre farmyard manure . C

The crop was a bulrush millet. Yields of grain showed no increase for T1 as compared with T2. Further, the individual rock phosphate treatments showed no increase over the control C.

When, however, the two rock phosphate treatments were considered together in comparison with the untreated farmyard manure there was a significant increase in grain yield of 13 per cent. This confirms earlier work done here with ground rock phosphate.

As regards vegetative growth T1 alone showed a significant increase over C. When T1 and T2 were considered as one there was an increase of more than 45 per cent. over the control.

INSECT PESTS

Tsetse Fly

Nigeria.—The following account of tsetse research is contained in the report of Mr. F. D. Golding, Senior Entomologist, on the work of the Entomological Section, Agricultural Department, for the period July to December 1937.

Two more fly surveys of the proposed unit farm areas in the Ilorin Province were carried out in July-August and in the first half of November. With the exception of two individuals of *Glossina tachinoides* Westw., all the tsetses collected in the unit farm areas in the three surveys were *G. palpalis* R. D. A standard system of collecting was employed in order to provide comparative data as to the abundance of fly in each area. On the conclusion of the third survey, the areas were roughly grouped according to the number of flies collected during the three surveys. These data were employed by the Agricultural Officer in charge of the Middle Belt cattle scheme when selecting areas in which to establish the nine new unit farms to be opened in 1938. An interesting feature of the November survey was the abundance of Tabanid flies and *Stomoxys* spp. It is evident that these flies are numerous only between the end of the short dry season and the end of the rains (September to mid-November). Of 899 flies collected by a herdsman on Gold Coast cattle on the Ilorin farm between October 10th and 29th, 19 were Tabanids (belonging to the genera *Tabanus*, *Haematopota* and *Hippocentrum*), 153 were *Stomoxys* spp., and 727 were non-biting Muscids. On August 18th, *Lyperosia minuta* Bez. was taken on trade cattle in the market in Ilorin Town; this species was not found on the stock farm two miles away.

INSECTICIDES

Derris

Malaya.—Mr. B. Bunting, Senior Agriculturist, in his report for the half-year, July-December 1937, states that considerable attention was given at the Central Experiment Station, Serdang, to the cultivation of *Derris elliptica* Changi No. 3 and a 5-acre plot, planted 3 ft. × 3 ft., produced over 200,000 cuttings at the end of the first year. As previously reported this is a very strong rooting type of Derris and under suitable conditions of planting practically no losses are obtained when fresh cuttings are planted direct in the field. This statement was recently proved under fairly large-scale plantation conditions with 155,000 cuttings.

The clonal investigations were continued and cuttings were taken from an established Changi No. 3 clone, which analysed 13 per cent. rotenone and 30 per cent. ether extract.

Mr. G. H. Corbett, Senior Entomologist, reports that experiments have been carried out with a view to ascertaining the effect of Derris and its constituents on as many different insects as possible.

Derris in the form of aqueous solutions made from three types, *D. elliptica* Changi No. 3, *D. elliptica* Serdang type, and *D. malaccensis* var. *sarawakensis* was used as well as dusts composed of the ground root or of pure rotenone. The results of the spraying and immersion experiments show considerable variation, but in experiments in which dusts have been employed, the preliminary results are more consistent.

Further confirmation that rotenone, deguelin and toxicarol incorporated in an innocuous substance, such as tapioca flour, are non-toxic as stomach poisons to the cockroach, *Periplaneta americana*, has been obtained, and it has been ascertained that most adults and larvæ of *Epilachna indica* Muls. die within twenty-four hours after being placed on the leaves of *Solanum melongena* which have been dusted with rotenone mixed with tapioca flour.

The report of Mr. C. D. V. Georgi, Senior Chemist, for the period July to December 1937, contains the following statement relating to work carried out on Derris.

1.—The results of analysis of roots from individual plants of different types of *Derris malaccensis* indicated that *D. malaccensis* var. *sarawakensis* had the highest rotenone content and ether extract. The rotenone content is, however, not high enough to allow of the root being sold on such a basis. A summary of the results is given below. The plants were all between 23 and 24 months old when lifted and the figures for rotenone and ether extract are calculated on a moisture-free basis.

Type of Root.	Average Rotenone.	Average Ether Extract.
	Per cent.	*Per cent.*
D. malaccensis var. *sarawakensis* .	3·8	24·5
Do. tuba merah . .	1·3	22·1
Do. Kinta type . .	0·8	22·7

2.—The experiment being carried out at Serdang in connection with the variations in yield of root and toxic content with increase in age of plants has been continued. The variety under trial is *D. malaccensis* var. *sarawakensis*. A summary of the results to date is given below. The figures for ether extract are calculated on a moisture-free basis.

Age of Plants.	Yield of Marketable Air-dry Root per Sub-Plot.			Ether Extract.		
	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.
Months.	*lb.*	*lb.*	*lb.*	*Per cent.*	*Per cent.*	*Per cent.*
15	4·14	1·48	2·51	29·05	18·67	24·95
18	4·65	1·64	2·34	29·72	19·26	23·41
21	4·91	2·10	2·95	25·88	17·72	21·79

The results are of interest in that they show a marked increase in yield of root between 18 and 21 months and a decrease in the ether extract. No explanation can at present be offered to account for these differences. Further samples are being analysed.

3.—The results of analysis for clonal plants to-date are somewhat surprising. The species studied are *D. malaccensis* var. *sarawakensis* and *D. elliptica*, Sarawak creeping.

Although the plants are not old enough yet to be able to effect an age for age comparison, the figures indicate it is unlikely that even at 24 months (the age of the plants when the cuttings were taken) the results of analysis of the roots for the two generations of plants will be in agreement. A brief summary of the results to-date is as follows :—

(*a*) The appearance of the plant above ground bears no relationship to the development of root. There are wide variations in yield of root from individual plants in a row.

(*b*) The high yield of root from Sarawak creeping plants compared with that from var. *sarawakensis* plants. The figures below show the variations found in these two respects with marketable roots from plants 17 months old. The plants are set in rows 8 ft. apart with 5 ft. between the plants in the rows.

Serial No. of Plant.	Weight of Air-dry Marketable Root per Plant.	
	D. malaccensis var. *sarawakensis*.	*D. elliptica*, Sarawak creeping.
	oz.	*oz.*
1	6·5	28·3
2	5·0	13·4
3	10·4	14·6
4	9·0	17·2
5	10·5	9·6
6	3·4	18·0
7	6·8	10·0
8	3·4	20·8
Average	6·9	16·5

(*c*) The character of the root varies with the individual plant. That from some plants contains a large proportion of roots varying from ½ in. to ¼ in. in diameter ; others contain a large proportion of very fine roots, less than ⅛ in. in diameter. The variation is more marked with *D. elliptica*, Sarawak creeping, than with *D. malaccensis* var. *sarawakensis*, as the figures in the following tables show.

Derris malaccensis var. *sarawakensis*

Serial No. of Plant.	Weight of Air-dry Marketable Roots.	Proportions of Roots of Different Sizes.		
		½ in—¼ in.	¼ in.—⅛ in.	⅛ in. and less.
	oz.	*Per cent.*	*Per cent.*	*Per cent.*
1	11·2	25·2	48·7	26·1
2	12·4	29·0	38·5	32·5
3	4·7	22·2	46·8	31·0
4	5·2	24·8	43·3	31·9

Derris elliptica, Sarawak creeping

Serial No. of Plant.	Weight of Air-dry Marketable Roots.	Proportions of Roots of Different Sizes.		
		½ in.—¼ in.	¼ in.—⅛ in.	⅛ in. and less.
	oz.	*Per cent.*	*Per cent.*	*Per cent.*
1	16·8	43·6	38·8	17·6
2	15·3	25·7	46·2	28·1
3	21·5	34·4	37·0	28·6
4	17·2	22·5	51·3	26·2

(*d*) Wide variations are found in the ether extract of marketable roots from clonal plants in the same row as the following figures for two series of plants aged 17 months show. It is to be appreciated that the results are not strictly comparable as the roots from the parent plants were taken when the latter were 24 months old.

	Derris malaccensis var. *sarawakensis* (Ether Extract (moisture-free basis).	*Derris elliptica*, Sarawak creeping Ether Extract (moisture-free basis).
	Per cent.	*Per cent.*
Parent Plant 24 months	20·88	25·36
Serial No. of Plant. 17 months.		
1	22·30	24·05
2	27·56	29·22
3	27·06	26·98
4	28·78	24·67
5	25·93	22·24
6	19·91	24·50
7	20·77	21·42
8	20·83	19·74
Average	24·14	24·10

The variation between maximum and minimum is too great in either case to be accounted for by differences in the character of the root. Analyses showed that the variations in ether extract of the different sized roots were small. A typical set of figures is as follows :—

Size of Roots.	*Derris malaccensis* var. *sarawakensis* Ether Extract (moisture-free basis).	*Derris elliptica*, Sarawak creeping Ether Extract (moisture-free basis).
	Per cent.	*Per cent.*
½ in—¼ in. . .	26·36	19·04
¼ in.—⅛ in. . .	25·41	25·13
⅛ in. and less .	22·81	21·63
Average . .	24·84	22·03

It is interesting to note that with *D. malaccensis* var. *sarawakensis* the roots from ½ in. to ¼ in. have the highest ether extract, but with *D. elliptica*, Sarawak creeping, the roots from ¼ in. to ⅛ in. are highest.

(*e*) Similarly to the ether extract the rotenone content shows a wide range of variation. The proportion of rotenone to ether extract remains, however, approximately constant for a particular type, e.g. 15 per cent. for *D. malaccensis* var. *sarawakensis* and 25 per cent. for *D. elliptica*, Sarawak creeping.

The above proportions hold good for marketable roots from plants between 12 and 24 months.

4.—The results of analysis of a sample of marketable roots of *Derris uliginosa* plants show both the rotenone content and ether extract to be very low as the following figures, calculated on a moisture-free basis, indicate.

	Per cent.
Rotenone	0·5
Ether extract	5·0

BEVERAGES

Tea

Malaya.—According to the report of Mr. B. Bunting, Senior Agriculturist for the half-year July-December 1937, the lowland tea at Serdang planted at an elevation of about 100 ft. in 1924 has shown remarkably high yields and the Dangri variety produced over 1,500 lb. of made tea per acre per annum during 1937.

A break of 72 half chests was forwarded to London in July; the prices realised for the different grades comprising the consignment were as follows:—

B.O.P. . . .	1s. 2½*d.*
O.P.	1s. 2¼*d.*
Pekoe . . .	1s. 1¾*d.*
Fannings . . .	1s. 2¼*d.*

Although the tea is somewhat lacking in flavour it apparently has a special value for blending purposes.

CEREALS

Guinea Corn

Nigeria.—According to the report of Mr. J. K. Mayo, Agricultural Botanist, Northern Provinces, for the half-year July-December 1937, trials with guinea corn were carried out at two stations near Zaria but 25 miles apart. As was foreshadowed in last year's report (this BULLETIN, 1937, **35**, 226) fresh local mixture was obtained from the Zaria district as standard and the old one treated as a variety. So far the result of only one of these trials is available, viz. that at Maigana, which was carried out on ⅛-acre plots with four repeats using Faulkner's method. The yields in lb. threshed grain per acre were as follows:—

		Percentage of New Local Mixture.
New Local Mixture .	596	100
Old Local Mixture . .	629	105
Strain T	656	110
Strain SH . . .	633	106
Strain D . . .	628	105
Strain M7 . . .	713	120

Strain T and M7 gave significantly higher yields. M7 being a new strain and far from pure lends support to the suspicion that hybrid vigour plays a part in the yields of the local sorghums.

Rice

Malaya.—Mr. R. B. Jagoe, Botanist, in his report for the half-year July-December 1937, states that progress has been made with experimental work on rice, especially in the extension of work on selection of local varieties in the more important padi growing States and Districts. The policy with regard to padi is the reduction of a multiplicity of grain types in each district, and the encouragement and provision by selection of local varieties, by introduction of other selections or by breeding of the minimum number of suitable and improved strains of varieties with approved grain type.

Mr. J. H. Dennett, Senior Chemist (Soils), reports that the investigations into the alleged deleterious effects of slimes from tin dredges in irrigating water for rice were continued. Standard slimes varying from 0-560 parts per 100,000 of water were used to irrigate padi grown in large pots. Results to the end of the period under review indicated that the presence of slime up to the maximum amount used, is progressively beneficial.

Three series of germination tests were carried out to ascertain the tolerance of different types of padi to salt water. The results show that, in general, germination is inhibited with concentrations of salt of 1·0 per cent. and higher. Siam type was not completely inhibited until a concentration of 1·5 per cent. was reached, while Chubai 18 did not germinate at all in a 1·0 per cent. solution.

According to Mr. G. H. Corbett, Senior Entomologist, the work on rice borers, principally *Diatraea polychrysa* Meyr., has been continued. The fluctuations in the number of egg-masses and yields have followed the same general trend as in the past three years, but so far a correlation between total bored stems and yields has not been found. Interesting results have been obtained from growing rice in cages giving partial protection from borers. The most interesting fact which emerges from four series of sowings is that tillering is greatly reduced. An investigation to ascertain whether fluctuations in egg-parasite population occur, and whether the removal of egg-masses from the leaf appreciably affects the yield of rice has been commenced. Borer-resistant padi from Nanking withstood heavy borer attack, and gave excellent yields in the first two generations, but seed from the third generation failed to germinate except after refrigeration.

ROOT CROPS

Cassava

Nigeria.—In his report for the half-year July-December 1937, Mr. F. D. Golding, Senior Entomologist, states that during the period under review, mosaic was found to have spread as far north as Bode Sadu in the Ilorin Province and specimens of diseased leaves were received from Jengre in the Plateau Province. There are indications that the disease is spread by means of infected cuttings imported from farther south. It has been established that the Aleurodid vector is present as far north as Daura in the Katsina Province (latitude 13 deg. N.) near the Nigerian frontier.

Mosaic was observed for the first time on the Ilorin farm in July. Mosaicked plants were uprooted and destroyed and the disease appears to have been eradicated; mosaic is now common near Ilorin Town.

Sweet Potato

Nigeria.—Mr. Golding also reports that in early November several acres of sweet potato (*Ipomoea batatas*) on the Ilorin farm were attacked by the larvæ of the Convolvulus hawkmoth (*Herse convolvuli* L.). This is the first record of this moth on a pest scale in Nigeria. A large proportion of the larvæ were destroyed by labourers armed with sticks and by crows and kites.

FRUITS

Citrus

Dominica.—Mr. H. B. Pidduck, Acting Agricultural Superintendent, has furnished the following report on investigation work carried out in Dominica during the half-year July-December 1937:

Lime Breeding Work.—The budding hybrids raised from seedlings obtained by the back-crossing of back-crosses of the F.1 generation have made good growth and some have fruited. Those with fruits approximating the characteristics of the West Indian lime will be retained for observations as to their degree of resistance to withertip disease and for extended trial if necessary.

Stock Trials for Limes.—The triplicate series of limes budded on sour orange, rough lemon and grapefruit stocks continue to bear well, the heaviest crops having been obtained from those on grapefruit stock. Owing to unfavourable weather conditions and the late crop, much of which is still on the trees, yields were not quite as good as last year.

Grapefruit and Orange, Variety and Stock Trials.—The trees have made further satisfactory growth and considering their age, which varies from 4 to 5 years, gave fair crops. One of the objects of this trial is an attempt to extend the season by means of early and late varieties, and there are already indications that certain varieties are likely to fulfil these conditions.

Government Fruit Farm.—The planting of fillers has now been completed and the young trees are doing better than did the original trees at the same age. This is probably due to the attention given to protection from wind by the establishment of permanent windbreaks and the planting of tall growing cover crops, especially *Tephrosia candida* and *Crotalaria* spp. The older trees bore a small crop, a proportion of which attained export standard and was disposed of in Canada. As a result of soil analyses, the system of applying fish manure and sulphate of ammonia has been discontinued, and the trees now receive a mixture rich in phosphate twice yearly. Experiments are also being made with the application of lime.

Plant Distribution.—Owing to shortage of funds last year for raising stocks and abnormally hot, dry weather this year, the number of plants distributed was much lower than usual. Among those distributed in 1937 were: West Indian limes, 3,327; Washington Navel oranges, 1,817; other oranges, 283: Marsh grapefruit, 412.

Increased funds have made possible the raising of larger numbers of citrus stocks for budding and other economic plants during the past half-year and the demand for such plants should be readily met in 1938.

Demonstration Plots, Experiment Station.—The lime trees top-worked on grapefruit budded on sour orange and planted last year have made good growth. The object of this trial is to determine whether the heavier yields on grapefruit stock referred to above can be combined with the resistance of the sour orange stock to root troubles.

A similar experiment is being tried with Tahiti and Bears' seedless limes. These limes are shy bearers when budded on sour orange stock, but are reported to do well on sweet orange. In Dominica, however, the latter is very subject to footrot and other root troubles, and a number of plants have been raised by top-working the seedless lime varieties on Valencia orange plants budded on sour orange stock. The young plants experienced very hot, dry weather when first planted, but are now recovering and beginning to grow.

The lime shade plots have made very satisfactory progress. Two plots contain shade trees of *Peltophorum ferrugineum*, *Adenanthera pavonina* and *Cassia siamea*, which it is hoped will reduce the incidence of withertip disease in these plots by sheltering the lime trees from dew and light rains. Two other similar plots were planted without shade trees as control.

Top-working of Lime Trees.—A number of lime trees budded on sour orange stock were top-worked with Marsh grapefruit in 1934, and the following year a few trees on rough lemon and grapefruit stocks were similarly treated. The majority of the trees have made good progress, and some of them have given a small crop of saleable fruit this year.

Nigeria.—Mr. E. H. G. Smith, Botanist, Southern Provinces, in his report for the period July-December 1937, states that supplying of the citrus experimental plots at the departmental farms was carried out in 1937. A new plot containing a grapefruit and a sweet orange stock trial was established at Nkwele farm, Onitsha, in June. The two scions used were Ogbomosho Marsh seedless grapefruit and Florida Valencia orange, respectively. The trials were laid out in the form of two adjacent Latin Squares, with a single trace as the experimental unit and with a non-experimental border row of trees round the new plot. The following six stocks were used: sour orange, rough lemon, sweet orange, grapefruit, shaddock and acid lime. The existing citrus plot at Nkwele, begun in 1934, on hillside land has not so far shown great promise. The new experiments were planted on valley land in another part of the farm.

During 1937 appreciable citrus distribution was made as in recent years from the botanical nursery at Ibadan. Plants were supplied as follows:—

Departmental Planting—Southern Provinces . .	224	trees
,, ,, Northern Provinces . .	419	,,
General distribution to farmers, and for miscellaneous compound planting both North and South . .	1,881	,,
Total	2,524	,,

The above general distribution was made through the Agricultural Officers, and is additional to trees supplied from other departmental nurseries.

Grapes

Palestine.—The following account of work on grapes is taken from a report on agricultural research conducted in Palestine during the half-year ended December 31, 1937, which has been furnished by the Colonial Secretary.

Retarding the Ripening of Grapes.—A few thousand bunches of Muscat of Hamburg, Sultanina and Eynuni grapes enclosed in paper bags, ripened 7 to 10 days later than the control bunches which were not bagged. This experiment has further shown that bagged bunches were not attacked by the grape berry moth (*Polychrosis botrana*) whereas the uncovered bunches were very seriously infested.

"Pinching" and its Effects on the Vine Crop.—"Pinching" the growth of trellissed vines in the coastal and Emek vineyards was carried out on large areas with satisfactory results. The same procedure, however, when adopted in vineyards of the Jordan Valley was detrimental to the crop which suffered severely from sunburn.

Girdling of Grape Vines.—Further studies in girdling and its effect on early ripening were instituted. In the past girdling was done on the old wood and its effects were favourable as far as hastening the bunches were concerned, but had a considerable weakening effect on the vines.

Girdling of the young canes, just below the bunch, was tried this year with Muscat of Hamburg and Madeleine. The results were quite favourable. The grapes ripened 7 to 8 days earlier, and there was no apparent damage to the vines.

Introduction of New Varieties of Grapes.—Out of the many varieties introduced into Palestine the following varieties are showing good prospects: Black Monnuke, Flame Tokay, Pearl of Czaba, Italia and Blue Serbian.

Pests and Diseases.—The experiments on the control of *Polychrosis botrana* (the grape berry moth), mildew control on the vines, and the finding of substitutes for arsenical insecticides for use on vines were continued, and considerable success attained by the use of a mixture of sulphur (locally quarried) and barium fluo-silicate.

FODDERS

Palestine.—Experiments on the growing of cow peas (*Vigna sinensis*) as a green fodder have been conducted by the Division of Agronomy and Seed-Breeding of the Jewish Agency Agricultural Station, Rehovot. The following particulars are taken from a report on the research work carried out at the Station during the half-year July to December 1937, which has been furnished by the Colonial Secretary, Palestine.

The cow peas gave a yield of 30-40 tons of green matter per hectare, as compared with 40-45 tons in the case of Canadian field peas and 25-30 tons of horse beans. It is thought that this yield may be improved by inoculation. The best varieties of cow peas under local conditions were found to be Whip-poor-Will and Brabham. The quantity of seed needed for sowing is 7-8 kilos per donum (=0·23 acre) and the sowing season may be extended from April to the middle of August. The growing season lasts 8-10 weeks. The water requirement varies from 250 to 500 cubic metres per donum, depending on the method of irrigation, the soil and the local climate. It is considered that cow peas may become the most important summer forage crop of the district.

The cow pea has also proved satisfactory as a green manure, for which purpose the Brabham variety, which is supposed to be resistant to nematodes, may be best suited.

The report of the Rehovot Station also contains the following results of an investigation carried out by the Animal Nutrition and Husbandry Section of the Division of Chemistry to determine the digestion coefficients of lucerne and ground-nut cake.

DIGESTION COEFFICIENTS

	Crude proteins.	Crude fat.	Crude fibre.	Nitrogen-free extract.
Lucerne . .	78·8	38·3	49·2	77·5
Ground-nut cake	93·6	88·5	15·1	68·5

OIL SEEDS

Ground-nuts

Nigeria.—Mr. J. K. Mayo, Agricultural Botanist, in his report on the work of the Botanical Section, Northern Provinces, during the half-year July-December 1937, states that there was a trial of erect strains selected from the indigenous variety at Zaria against the unselected variety. Randomised blocks were used with 8 repeats. The following was the result :—

Strain.	Yield of kernels per acre.	Percentage of standard.	Shelling percentage.	Yield of haulms per acre.	Percentage of standard.
	lb.			*lb.*	
T	551	113	71·2	1250	105
CC	503	103	68·0	1233	103
E	521	107	69·7	1314	110
Control	487	100	69·6	1193	100

There was no significance either for kernels or haulms. The correlation between weights of haulms and weights of unshelled nuts was

= +0·83 which was highly significant at ·01 probability.

T and CC are the same strains as those described in last year's report. Thus although this trial was not significant the cumulative results of several seasons indicate that T, and to a lesser extent CC, are actually superior to the Control.

OIL SEEDS

Oil Palm

Malaya.—The following statements relate to the work of the respective Sections of the Agricultural Department during the half-year July-December 1937.

Mr. B. Bunting, Senior Agriculturist, reports that in order to meet the greater demand for selected oil palm seed provision was made for increasing controlled pollination of high-yielding palms. Second generation palms are now in bearing and a third generation is now in course of preparation. The parent palms of this progeny gave an average yield of approximately 400 lb. of fruit bunches over a period of 13 years.

It is estimated that the new arrangements which have been made at Serdang will result in the production of 150,000 selected seed from the high-yielding palms and 350,000 from the second generation palms or a total of 500,000 during the year 1938.

A composting experiment with oil palms was also arranged at Serdang and provision made to prepare compost from bunch residue mixed with cattle dung and wood ashes.

Mr. R. B. Jagoe, Botanist, states that selection work on oil palms is being made on a wide basis and includes an area on a local estate, a large block of " Deli " type at the Central Experiment Station, and a block of introduced West African varieties, including a number of lines of " tenera " type.

Characters now being considered in making selections are: 1, yield of fruit bunches; 2, percentage clean fruit to bunch; 3, size of bunch; 4, percentage pericarp on clean fruit; 5, shell thickness; 6, size of kernel; 7, pollen production; and 8, carotene content in pericarp.

Regarding carotene content, this should be low for ordinary estate production of oil, but a high content is required for selections which may lead to the production (on a much smaller scale) of oil for nutritional purposes.

Breeding work is also in progress. Selections have been selfed, and seedlings are being planted out in randomised rows for comparative study.

The relative importance of size of bunch and numbers of bunches is being studied; and a palm of low growing habit is being crossed with the highest yielders.

According to Mr. J. H. Dennett, Senior Chemist (Soils), a number of comprehensive experiments have been started to find a means of arresting deterioration of oil palms on certain peat and valley quartzite soils. The series includes deep manuring, manuring with minor elements, application of lime, heavy phosphate dressings, trials of composts made from oil palm bunch refuse and the use of shade for the protection of the soil in the first four years of growth.

Mr. C. D. V. Georgi, Senior Chemist, reports that colour determinations of oil from fruits of 833 individual palms of the West African variety established at the Central Experiment Station, Serdang, have now been made. The results show that in the case of 193 of these palms the colour of the oil is more than three times as deep as that from average Deli type of fruit. Colour value of oil is now being correlated with size of fruit; also proportion of pericarp in fruit, with the object of selecting outstanding palms in both respects for future breeding work.

Efficiency tests carried out with a NG1 Duchscher hand press, which is used so extensively in Nigeria, showed that with single pressing of the Deli type of fruit about 65 per cent. of the oil could be recovered. Secondary treatment of the pericarp residue resulted in the recovery of a further 7 per cent., making 72 per cent. in all. The final distribution of the oil was as follows:—

	Per cent.
Oil recovered	72·0
Losses of Oil:	
Pericarp residue	11·5
Surface of nuts	6·0
Sludge remaining after purification of oil	10·5
	100·0
Calculated oil content of fruit . .	30·8

Nigeria.—The report of Mr. E. H. G. Smith, Botanist, Southern Provinces, for the period July-December 1937, contains the following account of work conducted on the oil palm.

Oil Palm Planting.—In June 1937, a new ten-acre seed multiplication plot of the ordinary thin-shell type of oil palm was established at Ogba farm, Benin. In all, 583 palms were planted, viz., 407 self-fertilised seedlings raised from Aba selected palm No. 864, and 176 Lisombe seedlings raised from N'Dian seed. Clearing operations were begun towards the end of the period under review for a similar plot of 50 acres to be added at the same station in 1938. Aba and Lisombe seedlings have been produced for this plot at Ibadan and Onitsha.

The following summary is given of the approximate acreages of palms established at the departmental farms which are likely to be of value for selection, or for the production of superior seed for farmers. These include Calabar, Aba, Lisombe and Deli progenies, but not all seedlings were raised from self-fertilised (or control-pollinated) seed.

Areas of Useful Palms at Experimental Farms

Station.	Special Selection Plots.	Plots of value for Selection.	Multiplication Plots.
	Acres.	*Acres.*	*Acres.*
Benin (Ogba farm) . .	18	8	20
Onitsha (Nkwele farm) .	4	21	5
Umuahia (Umudike farm)	9·5	8	—
Ibadan (Moor plantation)	13·5	1	—
Calabar	—	10	—
Total in acres . .	45	48	25
Approximate number of individual palms at 60 per acre . . .	2,700	2,880	1,500

Thus, the Department now possesses some 7,000 useful palms, and of this number about 5,000 may be said to be specially selected. In addition, there are in the neighbourhood of 3,000 other plantation palms, planted for various experimental reasons, but which are unlikely to be of value for selection. As was recently described in an article in this BULLETIN, much more progress has been made in the Belgian Congo (" The recent improvement of African oil palms and palm oil production in the Belgian Congo," by E. Le Plae, *Bull. Imp. Inst.*, 1937, **35**, No. 2, pp. 174-180). In the Congo, by November 1936, 63,460 individual palms had been studied.

However, plans have been prepared for more extensive work in Nigeria, and it is contemplated that from 1938 onwards, for a period of years, in the neighbourhood of 3,000 to 5,000 selected palms will be added annually to the departmental plantings for all experimental purposes. Thus the figures in the above table give rather a pessimistic picture of the Nigerian position, although for some years this country is bound to be behind the Congo in the development of oil palm work. Progress in Nigeria was severely checked by the recent depression, as there was neither money to increase palm acreages on the scale that was required, nor to employ anything like an adequate technical staff in view of the immense problems to be solved.

Fortunately there are in actual fact more palms available for selection and experiment than is indicated above. The United Africa Company has started individual yield records at their N'Dian plantation, and has also arranged for palms at this and at two other plantations to be available for experimental work. The Department is greatly indebted to the Company for such invaluable assistance.

Oil Palm Selection.—In connection with the provision of selected seed for farmers, the Department has obtained control of two areas of natural palms. One, of approximately 27 acres, is at Aba in Owerri Province, and the other, of about 30 acres, is at Umunebo Ufuma in Onitsha Province.

Work at Aba is in the charge of Mr. J. W. Wallace, Agricultural Officer. Yield recording has been in progress for some years and a number of high-yielding individual palms have been discovered. Early work in this area was handicapped on account of the Department not having full control of the palms. During 1937 this defect was remedied, and all the palms have now been taken over. The work on the self-fertilisation of the outstanding Aba palms, which had been started earlier, was intensified during 1937, and appreciable quantities of seedlings from the Aba selections are now becoming available for departmental planting.

Recently, through the work of Mr. L. P. Henderson, Agricultural Officer, the Umunebo Ufuma palms have been obtained. These palms have been taken over during 1937 as a thin-shell seed multiplication area. The selection potentialities of the Umunebo Ufuma palms are likely to remain obscure until individual yield recording has been carried out over a period of years, but there is every prospect of valuable parent palms being found in this area.

The principal features of these two palm areas are different. The Aba palms are typical of a good natural oil palm grove. The large majority of the trees belong to the ordinary thick-shell form, and there are relatively few examples of the ordinary thin-shell form. The Aba palms are chiefly of value on account of the apparent high yielding capabilities of the best palms, and in this respect both thick- and thin-shell parent palms worthy of selection have been found. The Umunebo Ufuma palms are also typical, but of a less common type of natural palm grove, though of one which appears to be often found in Onitsha Province. At Umunebo Ufuma the proportions of ordinary thick- and thin-shell palms are more nearly equal. The latter excess of thin-shell palms—compared to the general average for Nigerian oil palm bush—seems only to occur in certain areas in Nigeria. Thus, while the Aba palms have been chosen for further study mainly on account of their apparent high yielding characters, the Umunebo Ufuma palms have been chosen because of large proportions of thin-shell palms in the total population.

In Mr. Smith's opinion the importance of obtaining departmental control of promising natural palm groves cannot be over-estimated. The study and exploitation of such palms appears to form an essential part of the work for the improvement of the Nigerian oil palm. It is to be hoped that it will be found possible to obtain the use of additional natural palm groves in the not too distant future.

Oil Palm Germination.—On account of the shortage of staff and of pressure of other palm work, germination experiments have only proceeded slowly during 1937. Following the indications obtained at Benin with " smoke-house " seed treatment by Mr. C. H. F. Walker, Agricultural Officer, tests have been made with charcoal in place of sand as a medium for starting germination in the Ibadan " germinators." The results so far obtained are distinctly encouraging, and appear to represent a further step forward towards the ultimate solution of the whole germination problem. In the present tests germination is started by placing the seed in trays filled with powdered charcoal in heated germinators. Each lot of seed is examined at weekly intervals, and all seeds that have started to grow are transferred to unheated trays of the pattern originally introduced by Mr. J. W. Wallace, Agricultural Officer. However, while this promising method may now be mentioned, it must be added that critical experimental tests between this and other germination processes have yet to be undertaken. It appears to be clear that a reasonably satisfactory and rapid germination of oil palm seed is only obtained where temperature, moisture and aeration are correctly controlled. The interplay of these three limiting factors is still to some extent obscure, but the requirements for good germination seem at last to be better understood.

Oil Palm Investigations.—In preparation for future selection programmes, oil palm analysis work on Calabar and other selected oil palm progenies has been carried out during the past year at Benin and at other experimental farms. The oil palm observations, previously described, have also been continued. Many of the results of this investigational work cannot become available until the African Assistant staff for oil palm work is augmented. It is quite impossible at present to examine all the masses of data that are accumulating.

Palm Weevil.—Mr. F. D. Golding, Senior Entomologist, in his report for the half-year July-December 1937, states that during the last 18 months, the weevil, *Rhynchophorus phoenicis* F., has been responsible for damage to young oil palms on the experimental farm at Nkwele, near Onitsha. In every case the palms were attacked at ground level and the trees were destroyed as a result of the larvæ eating their way almost through the stem. On July 12th, a dying palm was felled and found to contain 161 full-grown larvæ, 31 pupæ and 18 adults of *Rhynchophorus*. No evidence was obtained that weevil attack follows initial damage by Rhinoceros beetles, although *Oryctes erebus* Burm., is abundant at Nkwele. It was noticed that the base of each palm was surrounded by debris, which consisted mainly of fibrous material derived from old leaf bases, etc., which appeared to be attractive to termites. The debris has been removed in the hope that the weevils will not be able to effect an entrance to the trunks in the absence of termite damage. Trapping by means of fresh palm logs was carried out by the Agricultural Officer and resulted in 119 adult weevils being captured in six days.

LIVESTOCK

Apiculture

Palestine.—The following statement relating to experiments on the location of bee colonies (sun *versus* shade) is taken from a report on agricultural research work carried out in Palestine during the half-year ended December 31, 1937, which has been furnished by the Colonial Secretary.

An apiary consisting of 72 hives, divided equally into 12 rows, was so laid out on the eastern side of a Eucalyptus grove that the outside row (first row of hives) was 15 metres beyond the outer row of trees and free from any protection against the direct sun rays. The rows were placed at equal distances apart so that the fifth row was among the first row of trees and the sixth row among the third row of trees and subjected to the greatest amount of shade. Each row consisted of 9 standard single-wall Root hives and 3 Buckeye double-wall hives. All hives received identical care and management.

Data has been collected for the year October 1, 1936, to September 30, 1937, concerning consumption of sugar in all hives, condition of queens, bees and brood, temper of bees, quantity of comb foundation drawn, number of swarms and quantity of honey produced and the mortality of the colonies in each row.

From the results obtained it would appear that the placing of hives in the shade is much more desirable and practical than placing them in the open without any protection against the blazing sun. Particulars of the results are given below.

(*a*) The average production of honey in the first row was 8·9 kilos per hive with a marked and continued increase in succeeding rows to 20·5 kilos in the sixth.

(*b*) An average of 2·6 swarms were produced per hive in the first row whereas 4·3 swarms per hive were produced in the sixth row.

(*c*) 5·9 full combs of foundation were drawn in the first row; the corresponding figure for the sixth row was 14·3 combs.

(*d*) As to mortality of bee colonies, 4 died in the first row and only 1 in the sixth row.

(*e*) Hives in the first row consumed 9·7 kilos of sugar each and in the sixth row 10·1 kilos.

(*f*) The temper of bees was much more easily aroused in those hives of the sixth row than in those of the first, but this might probably have been due to the fact that the colonies in the first two were much weaker throughout the entire year than those of the sixth.

MINERAL RESOURCES

BRITISH GUIANA

The Imperial Institute has received from the Commissioner of Lands and Mines a report by the Director on the work carried out by the Geological Survey during the six months ended December 31, 1937.

The geological reconnaissance of the North West District commenced by Mr. S. Bracewell during the first half of 1937 was extended into the Barama River area by Mr. D. W. Bishopp and Dr. D. A. Bryn Davies.

Mr. Bracewell's report covering an area of about 600 sq. miles of the northern and western portions of the district is in the press. The report indicates that the bulk of the 500,000 ozs. of gold produced in the district has come chiefly from small placer operations, and that various attempts to introduce large-scale mechanical methods have been comparatively unsuccessful. For instance, in 1900 a dredge was installed in the Barima River which produced only 130 ozs. of gold; a drag-line scraper which was tried in the same river in 1924 was abandoned after producing only 106 ozs.; attempts at quartz milling at half a dozen different localities met with comparative failure (in one case a 20-stamp mill produced only 79 ozs.); and a number of well-financed expeditions have prospected the district without success. The history of some of these ventures is dealt with, and it is clear that they were doomed to failure from their inception owing largely to inadequate prospecting and ignorance of local conditions.

The annual gold production from the district of 35,935 ozs. in 1896-97 declined to 607 ozs. in 1929, but the gradual recovery of the industry is indicated by the production of 5,450 ozs. in 1936 and 5,713 ozs. in 1937. The future of the industry in this district, as of that in the Colony as a whole, is uncertain.

The following extracts are taken from Mr. Bracewell's report on the area examined by him :—

"There is a close similarity between the general geology of the Potaro and the Barima Goldfields ; whilst the Arakaka dolerite is apparently barren, there is a striking superficial relationship of the gold-bearing belt to the course of the main dolerite intrusion ; the richest placer deposits and the auriferous quartz veins worked in the past appear to lie within a belt about one mile wide on each side of the dyke for a distance of nine or ten miles. In the Potaro District there is a somewhat similar spacial association of the gold deposits with the Eagle Mountain-Tumatumari dolerite dyke and its extension into the Omai Goldfield ; this may be purely fortuitous, but it must not be overlooked and must be given due weight in any discussion of the origin of gold in these fields.

"There is obviously a need of further investigation, both in the field and in the laboratory, in both these areas ; further mining development may be necessary before conclusive evidence is obtainable. In the Barima River District, however, the present examination confirms Harrison's observations of the close relationship of many of the rich placer deposits with the metamorphosed basic rocks.

"In the Five Stars and Arawatta goldfields the headwaters of the rich auriferous creeks are in rugged hills of epidiorite ; five assays of these rocks have been made and show that they carry 2·6 grains and 5·2 grains of bullion per long ton respectively. The residual clays on the hillsides, derived from the epidiorite are auriferous in greater or lesser degree, and it appears certain that the gold is derived directly from these rocks.

"The granitic rocks outcrop in the lower portion of these areas and may extend more or less continuously beneath the epidiorites. Streams on the granitic rocks are comparatively barren, however.

"Harrison's observations of the auriferous nature of the metamorphosed basic rocks of the Aruka Hills have since been confirmed by Mr. W. T. Lord, who states that 'From observations made on the survey it would appear that the rocks in the district from which gold may be derived are the epidiorites and hornblende schists and the gravels derived from them.'

"In the Kaituma goldfields the auriferous lateritic gravel on Singh's and Waddle's claims and elsewhere is probably a residual product of the hornblende schist which forms the ridge to the immediate south-east of the workings.

"In the Baramita field geological conditions are somewhat different, although even here a dyke of hornblende schist passes close to the workings at Golden City and Old World.

The gold occurs chiefly in quartz veins and float derived therefrom. The veins occur within a lenticular area whose long axis corresponds with the well-defined line of contact between a granitic gneiss and schists. The veins traverse both the gneiss and the schists, and the area has been subjected to intense stress before and subsequent to the formation of the quartz veins. The contact may represent a fault plane between the gneiss and schist which has served for the passage of the solutions responsible for the gold mineralisation; the granitic rocks have been converted to greissen at Golden City, whilst the schists also have been considerably altered by hydrothermal agencies. Further work is necessary on this interesting area, and it is hoped that much useful information will be obtained as a result of the further mining developments which are foreshadowed in the section dealing with this goldfield."

Mr. D. W. Bishopp has recently examined an area of 160 sq. miles between Towakaima on the Barama River and Arakaka on the Barima River, and has submitted the following short account of this area:—

"Mazawini and Arakaka on the Barama and Barima Rivers respectively, are approximately at 190 ft. above sea-level. Towakaima on the Barama is some 40 ft. higher. The road between the two rivers crosses the watershed at Hyma Hill, between 500 and 600 ft. above sea-level; some individual hills on the Cassmaparu Creek near Towakaima attain from 700-800 ft., and suggest ancient base-levelling in two laterite benches occurring at heights of 480 and 695 ft. The country near the watershed line is rugged on a small scale, and cut up by small ravines with very steep sides.

"An acid igneous complex of considerable extent occurs on the Barama River in the neighbourhood of Towakaima. It consists mainly of granites and granitic gneisses. Farther to the north and east there are hornblende schists which are principally developed on the margin of the acid complex. These are followed by a group of metabasites, epidiorites and metadolerites. Northward again, following the Barama-Barima road toward Arakaka, there is a series of sericitic and argillaceous schists with broad intervening bends of sheared tuffs belonging to the ancient volcanic series of the Colony. These are intruded by metadolerite, and by some later dykes of unaltered dolerite.

"The principal foliation-strike of all these rocks, including that of the granitic gneiss at Towakaima, is from east to west, with dips close to the vertical. The contact of the gneiss and granite with the more basic metamorphics has however a north-westerly trend.

"Moderately coarse alluvial and eluvial gold is found principally on or close to the metadolerite and epidiorite areas, and near the contact of the acid igneous rocks with the preceding types. The gold is always associated with quartz gravel, and numerous quartz veins were located, some of these being of fair size. While they do, now and again, contain grains of coarse visible gold, the samples assayed showed a rather uniform content of 30-40 grains of silver per ton, in which the mean gold content was about 8 per cent. by weight of the silver value.

"All the small creeks have been heavily worked by 'pork-knockers' since about 1897; the values obtained were from 2-3 dwts. per cu. yd. While there are a few men at present earning a living in the area (and, of course, a great many more at other places on the Barama River), it would seem that practically all the gold, accessible to small workers in the limited area examined, has been worked out. The rocky and bouldery bed and the narrow deep valley of the formerly rich Hyma Creek do suggest, however, that some more gold might here be won by hydraulicking. The presence of gold in the top sands of the much larger Takutu River for a distance of several miles below the Hyma confluence has prompted the recommendation that some preliminary drilling and pitting should be undertaken in its fairly extensive flats with a view to dredging possibilities.

"No other minerals have been discovered, and a detailed report and map have now been prepared."

Dr. D. A. Bryn Davies has extended his previous survey of the Aranka Goldfield, Cuyuni River, northwards into the middle and lower portions of the Barama River, and has submitted the following brief summary of his work in this area:—

"In the Aranka district the more important gold occurrences are closely related to the margins of an auriferous granite batholith which covers an area of over 100 square miles. A similar association obtains in the middle Barama fields of Ianna, Yakishuru, and Pipiani, the gold occurring in and near several small apophyses of the Takie-Koriabo granite batholith, which occupies a large area between the Barama and Barima rivers.

"Although they lie within an area of only 12 sq. miles the gold deposits of the middle Barama fields are of the following distinctive types: at Ianna auriferous quartz veins and stringers are being worked at shallow depths and treated in small stamp-mills; at Yakishuru a mineralised shear-zone in decomposed volcanic rocks is being worked in open-casts and the gold recovered by sluices; while the Pipiani field is characterised by coarse gold (nuggets of up to 42 ozs. have been obtained) occurring in eluvial material near a granite contact.

" In the lower Barama, an examination was made of the Tassawini Mine district and of a gold-quartz occurrence near Kokerit. At the Tassawini Mine 11,000 ozs. of gold were produced by hydraulicking between 1907 and 1914. The mine was then abandoned owing to exhaustion of payable values. The gold occurs in a compact series of short parallel shear-zones in decomposed volcanic rocks, 2½ miles from the edge of the Takie-Koriabo batholith. The examination of the mine entailed detailed assay-sampling of the old open-cuts.

" An examination of rock outcrops along some 60 miles of the Barama River serves to link up the Tassawini and Ianna districts and provides useful information as to the structure of this area, while a traverse from the Cuyuni to the Barama River connects the mapping in the two drainage basins.

" The major structural feature of the Aranka and middle Barama districts is a persistent east-south-easterly strike. In the lower Barama a north-easterly strike is predominant. Several distinctive horizons, notably a manganiferous series, have been recognised in the lower and middle Barama and provide a key to the general structure of the region. Occurrences of manganese ore, as hill-cappings on the manganiferous rocks, are under investigation."

The geological survey of the North-West District will be continued during the early part of 1938.

CYPRUS

The Imperial Institute has received from the Inspector of Mines and Labour the following report on mining activities in Cyprus during the last six months of 1937.

A new record was established in the production of minerals during 1937, the total value of which amounted to £1,128,000 compared with £712,000 in the preceding year. The principal increase shown was in respect of cupreous pyrites, the total output for the year amounting to 796,000 tons, of which 388,835 tons of crude pyrites and 111,500 tons of cupreous concentrates were exported. A satisfactory feature of the year has been the development at the Kalavaso Mine, where a substantial body of pyrites has been discovered. The lessees of the mine are constructing a light railway over a length of 7 miles to the coast, where a loading plant will be installed.

Prospecting showed some falling off in the latter half of the year, expectations of many prospectors not having been realised.

There was an appreciable increase in the production of both asbestos fibre and terra umbra.

MINERAL PRODUCTION.

	Last 6 months 1937.	Last 6 months 1936.
Cupreous pyrites (dry weight)	*Tons.*	*Tons.*
Skouriotissa Mine, production	101,095	112,586
,, ,, exports	106,261	96,256
Mavrovouni Mine, production	311,643	193,426
,, ,, exports	91,982	24,030
Lymni Mine, production	7,556	Nil
,, ,, exports	1,602	Nil
Cupreous concentrates (dry weight)		
From Mavrovouni ore, exports	61,688	31,932
Cement Copper		
From Lymni Mine, exports	40	Nil
Chrome iron ore		
Production	746	Nil
Exports	480	Nil
Gold (contained in ores, concentrates and precipitates)	*Troy oz. fine.*	
Skouriotissa Mine	1,373	2,791
Mathiati Lease	10,256	9,557
Akoliou Lease	613	79
M.W. Berdy Lease	Nil	627
Prospecting Permit Areas	2,434	33
Silver (contained in ores, concentrates, and precipitates)		
Skouriotissa Mine	6,266	15,905
Mathiati Lease	50,497	55,411
Akoliou Lease	2,419	279
M.W. Berdy Lease	Nil	3,229
Prospecting Permit Areas	16,605	189
Asbestos (Tunnel Asbestos Cement Co., Ltd.)	*Tons.*	*Tons.*
Rock mined	901,982	936,370
Rock treated	222,345	188,953
Asbestos fibre produced	7,027	6,123
,, ,, exported	7,632	6,186
Other minerals exported		
Gypsum, calcined	2,298	2,851
,, raw	3,912	3,668
Stone, building *cu. yds.*	*Nil*	79
,, pumice	Nil	223
Terra umbra	3,016	2,252
,, verte	2	8

The following table shows the production and exports of certain minerals for the year 1937 :—

		Production.	Exports.
Chrome iron ore,	*tons*	1,615	481
Copper, metallic (*b*)	,,	27,000	27,000
Gypsum, calcined	,,	7,000	4,637
,, raw	,,	15,000	8,725
Gold,	*troy oz., fine*	(*a*)	23,650
Silver,	,, ,,	(*a*)	132,968

(*a*) *Information not available.*

(*b*) *Estimated copper content of cupreous pyrites and cupreous concentrates.*

NIGERIA

The Imperial Institute has received the following statement from the Director regarding the work carried out by the Geological Survey during the six months ended December 31, 1937.

Minerals

Gold.—The geological investigation of the goldfield was suspended during the half year owing to the absence on leave of the officer concerned. Field work will be resumed early in the New Year. The monthly output of gold showed a further decrease, the total production for the year being 26,047 ozs., compared with 33,364 ozs. for the previous year.

Oil.—An Exclusive Exploratory Licence for oil and bitumen has been granted to the Anglo-Saxon Petroleum Company, and two geologists belonging to the company have been engaged in preliminary field work in the Southern Provinces. An officer of this department accompanied the party for a short period in order to point out the features of the geological succession.

Water Supply

Wells.—The construction of wells was continued in Sokoto, Katsina, Kano, Bauchi, Bornu, Benin and Owerri Provinces. During the period 52 wells were completed, bringing the total for the year to 145, with a footage of 16,071 ft. sunk. The wells constructed in Katsina Province were situated in an area underlain by a complex of crystalline rocks (granites, diorites and schists) and the sinking frequently involved the use of jumper drilling and blasting. With the exception of a few shafts sunk to provide a water supply for a leper colony in Kano Province the wells in all the other areas were constructed in sedimentary rocks, and no difficulties were experienced.

Production tests are now being made on a shaft of 9 ft. diameter constructed at Katsina as a first step in the provision of a water supply for Katsina Town (population 22,000). The behaviour of the water-table is being studied in three observation shafts each of 4 ft. diameter, situated at distances of 100 ft., 200 ft. and 500 ft. from the main shaft. Pumping is to be continued until March 31, 1938, when the position will be reviewed in the light of the data which will then be available. Present indications are that the shaft will yield 22,500 gallons a day, but that pumping at this rate causes a wide cone of depression in the water-table.

Water supply investigations are being carried out in Calabar Province and in the Aba Division of Owerri Province.

If the results are satisfactory well-sinking will be commenced in these new areas in the near future.

Arrangements have now been completed for a programme of well-sinking in connection with the campaign to combat the spread of sleeping sickness. It is proposed to transfer the people from areas in which the incidence of the disease is high to areas which are relatively free from the tsetse fly. It is essential for the success of the scheme that an adequate supply of water should be provided in the proposed settlement areas. The first region to be dealt with is the Anchau district of Zaria Province, and the construction of wells in the settlement area in this district will commence early in the New Year.

Drilling.—Drilling is in progress at Nguru in Bornu Province with a view to providing a watering point for the Nigerian Railway. Water was met in a good coarse aquifer at 38 ft., but shortly below this depth loose saturated sands were encountered which immediately filled in the hole made by the chisel. It therefore became necessary to drive the casing, and this caused the perforations to become blocked. Clay was met at 95 ft., and drilling has continued normally in this material, but up to the present no sandy stratum of sufficient thickness to provide the required supply of water (36,000 gallons a day) has been met. If a suitable stratum is not reached within a reasonable depth it is proposed to exploit the first aquifer, which yields very freely, by means of a technique devised to suit the unusual conditions.

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PLANT AND ANIMAL PRODUCTS

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Sand: Its Formation, Production, Treatment, and Uses. By J. Watson. *Cement, Lime and Grav.*, 1938, **12**, 90-91, 111-113, 122, 136-138.

Areias: Composição e Applicações. By E. F. Rocha. *Inst. Nac. Techn., Brazil.* Pp. 27, 9 × 6¼. (Rio de Janeiro: Ministerio do Trabalho, Industria e Commercio, 1936.)

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Sulphur from Pyrites. By R. C. Rowe. *Canad. Min. J.*, 1938, **59**, 181-183. A brief note on the Comstock-Westcott process for extracting sulphur from the ores of the Aldermac Mine, Quebec.

IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 2

(January to March, 1938)

Prepared in collaboration with the Imperial Institute of Entomology and the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

GENERAL

Some Developments in Entomology in 1937. *Industr. Engng. Chem., News Ed.*, 1938, **16**, No. 1, 5. Brief summary of the principal papers on insecticides published during the year.

The Use of Plant Extractives or Dried Ground Plants in Insect Control offers a Broad Field for Research. By H. F. Dietz. *Agric. News Letter* (*Du Pont*), 1938, **6**, No. 1.

Report of the Work done in Mysore on the Insecticidal Value of Plant Fish-poisons and other Forest Products, from April 1936 to March 1937. Pp. 23. Deals with chemical investigations of *Mundulea suberosa* bark, *Tephrosia candida* seeds, and *Derris elliptica* roots, and with tests of a large number of different plants against various insects.

Report of the Chief of the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, 1937. Includes a summary of the chemical investigations on insecticidal plants (tobacco, derris, pyrethrum, etc.) and their constituents, carried out during the year ending June 30, 1937.

Investigations of Insecticidal Plants. By R. H. Moore. *Rep. P. Rico Exp. Sta.*, 1936, 72-74. (*R.A.E.*, 1938, **26**, A, Pt. 4, 224.)

Insecticide Literature and Patents. By J. Curlett. *Soap*, 1938, **14**, No. 1, 117-120. Review of the more important papers published during 1937 on pyrethrum, derris, and synthetic insecticides.

List of Publications of the Division of Insecticide Investigations, Bureau of Entomology and Plant Quarantine, Washington, from July 1, 1927 to June 30, 1937. Pp. 46.

List of Publications of the Division of Insecticide Investigations, Bureau of Entomology and Plant Quarantine, Washington, for the six months period ending December 31, 1937, together with a list of U.S. Patents by members of the Division granted during the latter three months. Pp. 4.

Reviews of United States Patents relating to Pest Control. Vol. 10 (1937), Nos. 10, 11 and 12; Vol. 11 (1938), No. 1. By R. C. Roark. *Bur. Ent., U.S. Dep. Agric.*

Laboratory Methods for the Biological Testing of Insecticides. By W. Steer. *J. Pom. Hort. Sci.*, 1938, **15**, No. 4, 338.

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ALKALOID-CONTAINING MATERIALS

Tobacco Products, including Nicotine and Nicotine Derivatives

How to make Tobacco-wash on the Farm. By M. C. Mossop. *Rhodesia Agric. J.*, 1938, **35**, No. 2, 130-133.

Nicotine Vaporizing Equipment for Field and Orchard Use. By R. H. Smith. *J. Econ. Ent.*, 1938, **31**, No. 1, 60-64.

Determination of Nicotine on Apples sprayed with Nicotine Bentonite. By L. N. Markwood. *J. Ass. Off. Agric. Chem., Wash.*, 1938, **21**, No. 1, 151-155.

Quantitative Injection and Effects of Nicotine in Insects. By N.E. McIndoo. *J. Agric. Res.*, 1937, **55**, No. 12, 909-921.

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Cabbage Aphis (*Siphocoryne indobrassicæ*) and its Control with Home-made Nicotine Spray. By V. G. Deshpande. *Agric. Live-Stk. India*, 1937, **7**, Pt. 6, 756-762. (*R.A.E.*, 1938, **26**, A, Pt. 4, 241.)

The Toxicity of Combinations of Nicotine under Michigan Conditions, to the Tree and to the Codling Moth (*Carpocapsa pomonella* Linn.). Pp. 47. (*R.A.E.*, 1938, **26**, A, Pt. 2, 79.)

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Exports of Nicotine Sulphate and Tobacco Extract from the United States. *Tobacco Markets, U.S. Dep. Comm.*, 1938, No. 659, 11-13.

Anabasine

Results of Comparative Tests on New Activators for Anabasine Sulphate in Combating the Beet Aphis. By E. N. Savchenko and N. G. Dzevaltovskaya. (In Russian.) *Nauch. Zap. Sakharn. Prom.*, 1937, **14**, No. 3, 34-42. (*R.A.E.*, 1938, **26**, A, Pt. 4, 237.)

INSECTICIDE MATERIALS CONTAINING ROTENONE AND ALLIED SUBSTANCES

General

Rotenone-containing Insecticides. By K. B. Edwards. *Fruit-Grower*, 1938, **85**, No. 2206, 460.

Les Plantes à Roténone. Leur Intérêt à Madagascar comme Insecticides. By C. Frappa. *Bull. Écon. Madagascar*, 1937, N.S., No. 9, 61-71. (*R.A.E.*, 1938, **26**, Pt. 2, 67.)

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Microscopic Rotenone Test. By E. Pozzi-Escot. *Soap*, 1938, **14**, No. 1, 129. Brief abstract of an article in *Rev. Cienc., Peru*, 1937, **38**, No. 418, 63-64.

The Solubility of Rotenone. II. Data for Certain Additional Solvents. By H. A. Jones and S. Love. *J. Amer. Chem. Soc.*, 1937, **59**, No. 12, 2694.

Rotenone-bearing Root Imports Steady—United States. *World Trade Notes, U.S. Dep. Comm.*, 1938, **12**, No. 7, 110. Quantities and values of imports for 1936 and 1937, of derris root and cube, timbo or barbasco root.

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Les Plantes à Roténone. Derris, Cube, Timbo. By J. Chevalier and M. Chevalier. *Bull. Sci. Pharm.*, 1937, **44**, No. 4, 223-241.

Niewe Handelsgewassen. By J. W. Roeloffs. *Bergcultures*, 1937, **11**, No. 52, 1846-1847. Brief account of the work on derris which is being carried out in the Netherlands East Indies.

Note sulla Coltivazione della Derris. By E. Suckert. *Agricoltura Colon.*, 1938, **32**, No. 1, 28-38.

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Derris uliginosa. By J. N. Milsum. *Malay. Agric. J.*, 1938, **26**, No. 1, 18-19.

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Rotenone in Derris and Cube Powder. Chloroform Extraction Method. *J. Ass. Off. Agric. Chem., Wash.*, 1938, **21**, No. 1, 79-80. Details of method, adopted as tentative by the American Association of Official Agricultural Chemists.

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Testing Pyrethrum as a Means of Codling Moth Control. By Chugunin. (In Russian.) *Plant Prot.*, 1937, Fasc. 13, 73-75. (*R.A.E.*, 1937, **26**, A, Pt. 2, 75.)

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Possibilités de Cultiver la Scille (*Scilla maritima*) en Tripolitaine et de l'Exploiter Industriellement. By G. M. Martelli. *Rev. Bot. Appl.*, 1937, **17**, No. 195, 844-846.

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NOTE.—The reference in brackets—*R.A.E.* etc.—which appears after certain items of the bibliography indicates the part and page of the *Review of Applied Entomology*, in which an abstract of the publication mentioned can be found.

NOTICES OF RECENT LITERATURE

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

PROBLEMS IN AGRICULTURAL MARKETING. By Deane W. Malott. Pp. xiii + 410, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1938.) Price 18*s*.

The author of this work is Associate Professor of Business at the Graduate School of Business Administration, George F. Baker Foundation, Harvard University, and, as is stated in the preface, the object of the book is to present concrete material for analysing the problems faced by those engaged in the various phases of agricultural marketing.

The work covers a wide field and deals with the problems of marketing faced by American producers of cotton, wheat, milk, tobacco, livestock and other agricultural products. The subjects dealt with include Auction markets, Uses of the Futures Exchanges, Co-operative marketing and advertising, Storage and transportation, and Financing. All the cases mentioned represent actual business situations, and are on this account useful not only to those interested in the theoretical aspect of agricultural marketing but also to agricultural producers who find themselves confronted with similar problems from time to time.

Valuable information is contained in the various problems presented regarding trading methods and technicalities in the sale of the commodities dealt with. Questions set at the end of each chapter enable the reader to form his own opinions as to the best solution of the particular problem under review.

The latter part of the book deals with national problems of agricultural policy, and a review is given of the various laws and Government schemes affecting agriculture in the United States of America.

An excellent bibliography is appended to each chapter and the author is to be congratulated on his valuable contribution to the literature on the economic aspects of agricultural marketing in America.

FARM AND GARDEN SEEDS. By S. P. Mercer, B.Sc., N.D.A., with a Section on The Seeds Act, 1920, by A. W. Monro, C.B. Pp. 205, 8½ × 5½. (London: Crosby Lockwood & Son, Ltd., 1937.) Price 10s. 6*d*.

The difficult problem of explaining the technicalities of a specialised subject in a way which will appeal to the non-technical man has been admirably overcome in this book, which is not only a valuable source of information for growers and all those connected with the seed industry, but is also well worth reading for its own sake.

After a preliminary chapter describing the nature of the seed, its formation, structure and germination, the text goes on to deal with commercial seed production and seed testing. Good accounts are given here of cleaning devices for the removal of weed seeds, and of the apparatus and technique used in seed tests.

From the practical point of view the last two chapters are probably the most important in the book. One is devoted to descriptions of the principal crop and weed seeds of the United Kingdom, and is accompanied by detailed drawings of nearly 50 crop seeds and some 120 weed seeds. The other, which is contributed by Mr. Monro of the Ministry of Agriculture and Fisheries, gives a clear explanation of the working of the Seeds Act, 1920.

In the two useful appendices which conclude the work, notes are given for practical seed testing and a table of physical data relating to crop seeds.

EROSION AND SOIL CONSERVATION. By G. V. Jacks and R. O. Whyte. Herbage Publication Series, Bulletin No. 25. Pp. 206, 9¾ × 7¼. (Aberystwyth: Imperial Bureau of Pastures and Forage Crops, 1938.) Price 5*s*.

This bulletin forms a useful contribution to the study of the soil erosion problem, being a survey of the present-day situation with regard to this menace in the countries where it has become most serious. In the case of each country considered an account is given of the erosion damage which has occurred, and its significance is discussed together with the primary causes and the measures which are being taken to check it. In compiling the book the authors have had the collaboration of scientific workers in all parts of the world, who, by the information which they have contributed, have materially added to the value of the work.

DEUTSCHE FASERPFLANZEN UND PFLANZENFASERN. By Prof. Dr. F. Tobler. Pp. 139, 9 × 6. (München-Berlin: J. F. Lehmanns Verlag, 1938.) Price Mk. 8.20 (Abroad, Mk. 6.15).

This well-produced and copiously illustrated handbook describes the principal plants which are, or might be, grown in Germany as sources of fibre, including not only well-known products such as flax and hemp but also numerous others, e.g. hops, willows, mulberries, lime-trees, hollyhocks, bulrushes, cereals, cotton-grass, sea-grass, etc. The use of the fibres of one or another of these for textile, upholstery or paper-making purposes is concisely dealt with. The extent to which some of the materials in question can be utilised in a country seeking self-sufficiency in raw materials may differ considerably from their possible economic outlets in the case of other lands, but as a summarised description of the plants concerned and the mode of employing their fibres the book is of considerable general interest. It will be of particular value to those desiring information on the lesser-known fibres.

COCOON SILK. A Manual for those employed in the Silk Industry and for Textile Students. By C. H. C. Cansdale. Pp. x + 230, 8½ × 5½. (London: Sir Isaac Pitman & Sons, Ltd., 1937.) Price 12*s*. 6*d*.

Books in English dealing with sericulture and the silk industry are sufficiently scarce to arouse special interest in the appearance of a new work on the subject published in England. The volume under notice is a useful addition to silk literature and in non-technical language covers a wide field. An introductory chapter on the history of silk is followed by an account of the origin and nature of the fibre which precedes a description of the principal silkworms of commercial importance and the methods of silkworm raising. Reeling and spinning are dealt with in one chapter and the manufacturing processes of silk dyeing and weaving are described. There are chapters on silk testing and research, rayon, and the uses of silk, and the work concludes with an account of the economics of raw silk and of new areas in which silk is now being raised or encouraged.

The book contains much information not hitherto readily available. The account of the efforts made to perfect automatic reeling machines is a case in point and, with the chapters on reeling, spinning and weaving, shows the author to be at his best in dealing with the mechanical aspects of his subject. The discussion of the economics of raw silk and the new areas of cultivation of mulberry silk are interesting and informative. The author considers that the main reasons for the non-success of the many attempts to establish commercial silk production in "new" countries have been failure to recognise the magnitude of the planning and effort necessary to achieve success, and a quite erroneous belief in a supposed simplicity of silk production. He quotes in this connection views expressed by the late Professor Lefroy when a member of the Imperial Institute Silk Production Committee. As a new area of culture the author mentions Mexico, describing the developments which have taken place in that country with American support; and reference is made to the interesting production of mulberry silk by Lady Hart Dyke at Lullingstone in Kent.

The book suffers from certain defects of arrangement and lack of balance. The re-grouping of the subject matter of the chapters on the "nature of silk" and "natural silk culture" might be considered; while the account of reeling in that on "silk reeling and spinning" might usefully form part of a section devoted to the sericultural aspect of the subject. Students will look for a fuller account of the "throwing" process; and in the section on testing and research some reference to the British Silk Research Association and its later development would have made the story more complete. The illustrations are useful, those relating to sericulture being apparently concerned with the Lullingstone industry.

SYNTHETIC RESINS AND ALLIED PLASTICS. Edited by R. S. Morrell, M.A., Sc.D., Ph.D., F.I.C., in collaboration with T. Hedley Barry, F.I.C., R. P. L. Britton and H. M. Langton, M.A., B.Sc. Pp. x + 417, 8½ × 5½. (Oxford: University Press; London: Humphrey Milford, 1937.) Price 21s.

This volume is intended to bring up to date the information on synthetic resins furnished by T. Hedley Barry, A. A. Drummond and R. S. Morrell in their *Natural and Synthetic Resins*, published by E. Benn, Ltd., in 1928.

As stated in the preface, the book is " of the character of a compilation," and in sixteen chapters it deals with the majority of substances generally regarded as falling within the range of synthetic plastics and varnish resins. The materials treated include phenol-formaldehyde and urea-formaldehyde resins, casein and cellulose plastics, vinyl, styrene, acrolein and acrylic acid resins, coumarone and indene resins, ester gums and glyptal resins, and various miscellaneous resins. The chemical and physical properties of the more important classes and their preparation are described, and chapters are also devoted to the manufacture and technique employed in moulding, the use of synthetic resins for moulded insulators, impregnating and finishing varnishes (in the electrical industry), the causes of resinification, and finally the methods of identification and testing of synthetic resins.

The authors have succeeded in compressing a mass of very useful information into a book of reasonable dimensions, but it is to be regretted that a book of this character should be marred by a number of instances of loose writing which render the meaning ambiguous or obscure.

SOLVENTS. By Thos. H. Durrans, D.Sc., F.I.C. Fourth Revised and Enlarged Edition. Pp. xvii + 238, 8½ × 5½. (London : Chapman & Hall, Ltd., 1938.) Price 15*s*.

A previous edition of this useful work devoted to solvents and plasticisers employed in the nitro-cellulose lacquer industry was reviewed in this BULLETIN, 1930, **28**, 258. The present edition, which follows the general lines of the earlier ones, has been subject to still further revision consequent upon the recent advances which have taken place in this industrial field. As before, the first part of the book is comprised of a series of chapters dealing in a clear and simple manner with the scientific and fundamental aspects of the subject. The chapter on plasticising solution has been rewritten, and contains much additional material. The same applies also to the chapters on toxicity of volatile solvents, of which over forty are dealt with. In the second part of the book a detailed description is given of the properties of the individual solvents, several appearing for the first time in the present addition, and also the specifications issued by the British Standards Institution and the American Society for Testing Materials. There are three useful appendices containing a dictionary of trade names, tables of solubility and plasticiser proportions. The book will continue to be of the greatest value to all those interested in the manufacture of cellulose lacquers and solvents.

Timber Products and Industries. By Nelson Courtlandt Brown. Pp. xviii + 316, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1937.) Price 17*s*. 6*d*.

In the words of the author, this book deals with the harvesting, conversion, and marketing of materials other than lumber, including the principal derivatives and extractives. The importance of some of these materials to the timber industry is perhaps not generally realised, indeed, it is stated in the preface that as much as one-half of the total volume of wood annually harvested from American forests is utilised for products other than lumber.

The book is divided into seven parts dealing with different aspects of wood utilisation. After an introductory section, two parts are devoted to construction materials, both on a large scale and for small wood containers, cooperage and crates, an account of plywood and veneer being included in the latter section. The products of chemical processes such as pulping and wood distillation are discussed together with extractives in another part, while wood flour and similar materials obtained by mechanical reduction also receive a separate section. Two further parts, dealing with wood as a fuel, and miscellaneous products conclude the text, but mention must also be made of the selected bibliography and the list of common and scientific names of native American trees, which contribute to the value of this useful and interesting work.

Outlines of Historical Geology. By Charles Schuchert and Carl O. Dunbar. Third Edition, Entirely Rewritten. Pp. v + 241, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1937.) Price 12*s*. 6*d*.

This brief outline of the story of the earth is based mainly upon the authors' larger work on *Historical Geology*, a review of which appeared in a former number of the Bulletin (1933, **31**, 617). The format, however, has been considerably altered for the sake of brevity, and many self-explanatory plates have been added to simplify the text.

The book is divided into four parts, Part 1 giving an interesting account of fossils and their significance, earth movements and the sub-division of geological time, and estimates as to the ages of rocks. From the data presented, it is concluded that the Tertiary period began about 60 million years ago, the Mesozoic era about 200 million years ago, and the Palæozoic era about 500 million years ago, the oldest dated pre-Cambrian rocks being 1,850 million years old. As the earth appears to be more than 2,000 million years old, it thus appears that three-quarters of geological time had transpired before the Cambrian period, which preserves the first abundance of life.

Part 2 deals with the changing features of the earth's crust, and shows that the repeated disturbances of the past have, in general, been no more violent than the slow growth and destruction of modern mountain systems. Glimpses are given of landscapes in various geological periods up to the Ice Age, when glacier ice spread over nearly one-fifth of the land surface of the world.

Part 3 is entitled "The Pageant of Life," and traces the evolution of living forms from primitive types to highly developed mammals, the story being continued in Part 4, devoted to the coming of man and his geological history. Thus the needs of the student, who wishes to get, in one brief course, a general survey of the past history of the world, are admirably fulfilled, and the authors are to be congratulated on the success they have achieved.

Outlines of Geology, Being a Combination of Outlines of Physical Geology, by Chester R. Longwell, Adolph Knopf and Richard F. Flint, and Outlines of Historical Geology, Third Edition, Entirely Rewritten, by Charles Schuchert and Carl O. Dunbar. Pp. 597, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1937.) Price 20*s*.

In response to a widespread demand from teachers of geology for an elementary text-book covering the salient features of physical and historical geology, the authors have combined in this volume their two former works, *Outlines of Physical Geology*, reviewed in the Bulletin (1934, **32**, 505), and *Outlines of Historical Geology*, which is noticed above.

The identity and pagination of the original works have been maintained in the present volume which is published at 20*s*., as compared with 31*s*. for the separate parts.

The work as a whole is particularly well illustrated, and should make a wide appeal among students.

International Control in the Non-ferrous Metals. By William Yandell Elliott, Elizabeth S. May, J. W. F. Rowe, Alex Skelton and Donald H. Wallace. Pp. xxi + 801, 9¼×6¼. (New York: The Macmillan Company; London: Macmillan & Co., Ltd., 1937.) Price 28*s*.

This exhaustive work, published by the Bureau of International Research of Harvard University and Radcliffe College, forms a companion volume to Dr. Brooks Emeny's stimulating treatise on *The Strategy of Raw Materials: A Study of America* *in Peace and War*, issued in 1934 and reviewed in this BULLETIN, 1935, **33**, 527.

The services of five research specialists have been enlisted in the compilation of the present work dealing primarily with the international control of the aluminium, tin, copper, lead, zinc and nickel industries. Each specialist has made an intimate study of the technological difficulties of the industries in question, as well as with their financial set-up, the general economics of controlled production, and the political repercussions of various control schemes.

Professor W. Y. Elliott, of the Department of Government attached to the Bureau, has undertaken the responsibility for outlining and co-ordinating the study, and, in addition to writing the introduction to the book, has contributed a chapter interpreting the political aspects of the problems arising from international agreements respecting non-ferrous metals. Mr. J. W. F. Rowe, of Cambridge University, has supplied a summary showing what he considers to be the proper economic usage of control schemes and the broad lines of policy according to which they should be conducted. Mr. Alex Skelton, now research economist of the Bank of Canada, has given a generalized account of the " mechanics " or organisation of international cartels, and has further contributed the detailed chapters dealing respectively with nickel, copper, lead and zinc. Dr. Elizabeth Stoffregen May, of Goucher College, has likewise furnished full accounts of the tin industry, and of the lead, zinc and copper industries of the United States, while Dr. Donald Wallace, of the Department of Economics at Harvard University, has supplied the valuable section dealing with aluminium.

Many interesting observations emerge from the general discussion, a few typical examples of which may be quoted :—

> " Long-run views would indicate that the nation which cultivates self-sufficiency is handicapped in all its efforts to hold investments abroad that may be necessary to its economic expansion."
>
> " These great economic systems, along the lines of a vast imperial bloc like the British Empire, or the Russian Union of Socialist Soviet Republics, or the regional agreements of an American system, may take the place of the older nineteenth and early twentieth century type of world market."
>
> " We may require to consider industrial stock-piling to take care of an uncertain future in such highly exhaustible minerals as tin is likely to be."
>
> " In spite of efforts such as the tin, rubber, wheat, and sugar plans, national groups do not seem able to reach and keep agreements which will prevent uneconomic production,

competitive 'dumping,' and struggles to possess huge sources of raw material and to exploit this possession by monopoly prices. If this is true, the era of *autarkeia*, or national economic self-sufficiency, which now threatens, must produce the most bitter political struggles."

Although many of the conclusions arrived at by the authors are debatable, the book can nevertheless be recommended as a serious and valuable contribution to an admittedly difficult and complex subject. It is unfortunate, however, that some of the technical descriptions regarding mining processes are inaccurate and that the authors did not always avail themselves of the latest statistics. Nevertheless, the work, as a whole, covers in an admirable way the vast and comparatively neglected field of international relations in the efforts being made by producers to reach international agreement with respect to quotas for annual production of basic commodities.

UNDERGROUND PRACTICE IN MINING. By B. Beringer. Second edition. Pp. xi + 277, 8½ × 5½. (London: Mining Publications, Ltd., 1938.) Price 21*s.*

The author of this book writes with a long practical experience, mostly on the Rand, where, as a result of uniform mining conditions over a very large area and fifty years of mining practice, the methods employed have become the most standardised in the world. The fact that the book is a second edition shows that it has supplied a want.

The various methods of supporting underground workings by means of timbering, pack-walling, concrete, masonry, temporary filling with ore, waste- or sand-filling, pillars and steel are fully gone into in the first 25 pages.

The different varieties of shafts sunk under various conditions, their respective advantages and disadvantages; methods of sinking, timbering, support and equipment; the François cementation process for dealing with water troubles; shaft stations; underground bins; the handling of waste rock, as well as driving, winzing and rising are dealt with in 69 pages.

Modern methods of stoping as applied under the various conditions of accessibility, ventilation, dip and thickness of the lode, the nature of the walls and the materials available for filling are described in 23 pages, being classified under the general headings of underhand, overhand and breast stoping.

A short section of 22 pages is devoted to the numbers and pointing of drill holes in development faces and in stoping; the breaking of ground with explosions, and the various methods employed for removing the broken rock. Another section of 36 pages is given to the production and distribution of compressed air and its economical use, as well as descriptions of certain types of rock drills now in common use on the Rand.

The author deals very exhaustively in 53 pages with the subject of mine ventilation. With mining depths reaching 1½ miles on the Rand, the subject has become of vital importance, and much research work has, consequently, been done in connection with it.

The last 42 pages of the book relate to mine sampling in all its aspects, including the calculation of ore reserves; mine management; the constitution, responsibilities, efficiency and discipline of the underground staff; contract systems; mining costs and safety first.

It might be noted that regarding sand-filling the author's remarks on page 23 refer to the Rand, where the sand is virtually clean silica and porous in bulk; in many other places the sand contains, besides silica, other material which acts as a binding agent, the whole packing tightly and consequently becoming far less subject to water penetration.

On page 121 the illustration given as of the "Australian Cut and Fill" is a rather incomplete one of the "Rilling" method, which is generally considered especially applicable to highly inclined lodes. With rilling stoping no timbering is necessary except for the cribbing of sand passes and manways and of ore passes, of which there is always one at the bottom of the rill. For a lode approaching 300 ft. in width, as presumably indicated in the diagram shown, a transverse vertical section would show that at least three stope drives would be necessary and that probably flat-back stoping was called for.

Apart from these minor criticisms the book is an excellent one. The author has compressed into it a large amount of useful and up-to-date information, but some of the numerous illustrations have unfortunately been reduced to such an extent as to be almost illegible.

ALUMINIUM-TASCHENBUCH. Achte Auflage. Pp. xviii + 377, 6½ × 4½. (Berlin: Aluminium-Zentrale, 1937.) Price RM. 2.50 inland, RM. 5.00 ausland.

This little book summarises in a handy form all the information that the user of aluminium and its alloys is likely to require. It deals with the metallography, physical and mechanical properties and methods of testing aluminium alloys, the principles of designing light alloys, casting, machining, hot and cold working, jointing and surface treatment of aluminium alloys, the uses of aluminium powder and foil, the use of aluminium in the electrical industry and the corrosion properties of aluminium alloys. It is, of course, primarily intended for German use, and the systematic DIN classification of aluminium alloys is used throughout. Users unfamiliar with this classification, however, will have no difficulty in tracing the information they require, assisted by a table correlating this classification with the prevailing alloy nomenclature of the other leading producing countries.

A short historical account of the aluminium industry and a summary of the German industrial organisation are included, together with numerous tables of physical and chemical constants and formulæ, conversion factors, etc., and a short bibliography. The book is aptly described by its title; it is compact and well bound and should prove of value to all interested in the aluminium industry.

Modern Methods of Refining Lubricating Oils. By V. A. Kalichevsky. Pp. 235, 9 × 6. (New York: Reinhold Publishing Corporation; London: Chapman & Hall, Ltd., 1938.) Price 30s.

The high standard associated with the many works issued in the American Monograph Series is fully maintained in this publication dealing with the various present-day methods of refining lubricating oils.

The book opens with a short discussion of the properties, such as viscosity, carbon residue, oxidation stability, pour-point and flash-point, which determine the value of a lubricant for specific purposes. In the second chapter a summary is given of the modern refining methods, which are divided into de-asphalting, solvent refining, and de-waxing. The sequence in which these operations are carried out in a refinery is variable and depends upon the particular products desired, but the author points out that to prevent undue loss of refined oil it is better for de-asphalting and waxing processes to precede solvent refining. In discoursing on these topics, however, he elects not to follow this order.

Subsequent chapters deal with petroleum waxes, their composition, effect on oil properties, and the various methods of removing them from oils. In this last connection an extensive chapter is devoted to solvent de-waxing, a phase brought about by the supply of relatively cheap solvents and the invention of continuous plant operation. Several useful tables of solvent properties are included in this chapter, and that on p. 49 summarising the properties of commercial solvents is of particular value.

After two small chapters on the removal of oil from paraffinic and ceresin waxes, and the nature of asphaltic substances, a short résumé of conventional methods of de-asphalting is given. As in the de-waxing phase, solvent extraction methods are becoming more universal, though the distillation and clay removal methods are still used. Accordingly the author deals exclusively with solvent de-asphalting in Chapter 9.

The latter half of the book is concerned principally with solvent refining, a process based upon the differential solubilities of petroleum hydrocarbons in certain solvents. General principles form the subject of Chapter 10, and the variable factors involved in selective solvents are denoted in Chapter 11. There then follows a sequence of three chapters on the types of solvent processes, namely those employing single solvents such as liquid sulphur dioxide, chlorex or dichloro-ethyl ether, furfuraldehyde, etc.; the relatively unimportant processes depending on mixed solvents, usually two in number, such as benzol and liquid sulphur dioxide; and the double solvents, each of which ideally exerts a preferential solubility, one for the deleterious constituents of an oil, and the other for the desirable elements.

Other topics include the disposal of solvent extracts, pour-point depressants, and viscosity index improvers.

An appendix of conversion tables, empirical equations for the thermal properties of petroleum products, and oxidation tests, and three valuable indexes of patents, authors and subjects form the concluding features of the book, which affords a remarkably concise survey of a widespread subject, and is further clarified by many useful tables and ten excellent plates illustrating typical refinery units.

THE PRINCIPLES AND PRACTICE OF SURVEYING. By Charles B. Breed and George L. Hosmer. Volume I, Elementary Surveying. Seventh edition. Pp. xxii + 717, 7¼ × 4¾; Volume II, Higher Surveying. Fifth edition. Pp. xxii + 674, 7¼ × 4¾. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1938.) Price, Vol. I, 20*s.*; Vol. II, 17*s.* 6*d.*

Additions to the already extensive bibliography on surveying must invariably be received with a certain degree of reserve, but progress in surveying practice always warrants the revision of standard works. Breed and Hosmer's Principles and Practice of Survey is now offered, the first volume having reached its seventh edition, and the second volume its fifth.

The first volume, which is divided into two parts and subtitled Elementary Surveying, has been completely revised, and in addition to the inclusion of many new problems, Chapter I has been enlarged by a more complete discussion of errors in measurement and their adjustment, and the sections of Chapters III and IV devoted to foreign instruments have been modified. It is regrettable, however, that no space has been allotted to the modern high-precision theodolites of British construction which certainly have few peers in the surveying instrument world. Further, the levelling method for a four-screw theodolite head is applicable to the United States, but in European countries, and particularly British overseas possessions, the tribach head is that in common use.

Other additions have been made to Part II on surveying methods. Chapter V, on the convergence of meridians, has been expanded, and the section on the stadia or tacheometer method of measuring distances in Chapter VII has been rewritten.

Volume II deals with higher surveying, and is in four parts, the first two being concerned respectively with control of the survey, and filling in topographic details; the third with photographic surveying; and the fourth with hydrographic surveying and stream gauging.

In Chapter I the description of the Bilby steel towers for triangulation is of particular interest since they have now been adopted by the Ordnance Survey in this country.

The part dealing with photographic surveying presents an admirable review of the subject which is further improved by several plates of the apparatus employed both for registering and reproducing the survey, and an anaglyph for which viewing spectacles are included.

Broadly, the two volumes present an able account of modern surveying methods in the United States, are well illustrated, and possess many valuable tables, but since they take practically no cognizance of British practice must have but limited appeal in this country.

BOOKS RECEIVED FOR NOTICE

THE CRUCIAL PROBLEM OF IMPERIAL DEVELOPMENT. Royal Empire Society Imperial Studies, No. 15. Pp. xiii + 201, 8½ × 5½. (London, New York, Toronto: Longmans, Green & Co., Ltd., 1938.) Price 6*s.*

VAN NOSTRAND'S SCIENTIFIC ENCYCLOPEDIA. Pp. 1234, 10½ × 7¼. (London: Chapman & Hall, Ltd., 1938.) Price 50*s.*

SCIENTIFIC HORTICULTURE (Formerly the H.E.A. Year Book). The Journal of the Horticultural Education Association. Volume VI. 1938. Hon. Editor: R. T. Pearl, B.Sc., A.R.C.S., D.I.C. Pp. xxxii + 260, 9½ × 6. (Wye, Kent: The Editor, *Scientific Horticulture*, S.E. Agricultural College, 1938.) Price 4*s.*

PLANT ECOLOGY. By John E. Weaver and Frederic E. Clements. Second Edition. Pp. xxii + 601, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1938.) Price 30*s.*

PHYSIOLOGICAL GENETICS. By Richard Goldschmidt, Ph.D., M.D., D.Sc. Pp. ix + 375, 9 × 6. (London: McGraw Hill Publishing Co., Ltd., 1938.) Price 24*s.*

AGRICULTURAL ANALYSIS. By C. Harold Wright, M.A., F.I.C. Pp. ix + 343, 8½ × 5½. (London: Thomas Murby & Co., 1938.) Price 16*s.*

THEORY AND PRACTICE IN THE USE OF FERTILIZERS. By Firman E. Bear, Ph.D. Second Edition. Pp. 360, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1938.) Price 20*s.*

KAKAO. Wandlungen in der Erzeugung und der Verwendung des Kakaos nach dem Weltkrieg. By Dr. Fritz Klopstock. Wandlungen in der Weltwirtschaft, Heft 12. Pp. viii + 138, 9 × 6¼. (Leipzig: Bibliographisches Institut Aktiengesellschaft, 1937.) Price RM. 6.50.

THE EVOLUTION OF SUGARCANE CULTURE IN MAURITIUS. By A. North Coombes, B.Sc., Dip. Agric. (Mauritius). Pp. xv + 197, 8½ × 5½. (Port Louis: The General Printing & Stationery Co., Ltd., 1937.)

THE CHEMISTRY AND TECHNOLOGY OF RUBBER LATEX. By C. Falconer Flint, Ph.D., D.I.C., A.I.C., A.R.C.S., B.Sc. Pp. xx + 715, 9¼ × 6. (London: Chapman & Hall, Ltd., 1938.) Price 42*s.*

DAIRY BACTERIOLOGY. By B. W. Hammer, Ph.D. Second Edition. Pp. xiv + 482, 9 × 6. (London: Chapman & Hall, 1938.) Price 25*s.*

GERMAN FORESTRY. By Franz Heske. Pp. xxv + 342, 9½ × 6½. (Newhaven: Yale University Press; London: Humphrey Milford, Oxford University Press, 1938.) Price 14s.

FOREST PATHOLOGY. By John Shaw Boyce, M.A., M.F., Ph.D. Pp. x + 600, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1938.) Price 30*s.*

A DICTIONARY OF WOOD. By E. H. B. Boulton, M.C., M.A. Pp. vi + 205, $7\frac{3}{4} \times 5\frac{1}{4}$. (London and Edinburgh: Thomas Nelson & Sons, Ltd., 1938.) Price 3*s*. 6*d*.

TIMBER. ITS STRUCTURE AND PROPERTIES. By H. E. Desch, P.A.S.I., B.Sc., M.A. Pp. xxi + 169, $8\frac{3}{4} \times 6$. (London: Macmillan & Co., Ltd., 1938.) Price 12*s*. 6*d*.

WOOD PRESERVATION. By George M. Hunt and George A. Garrett. Pp. ix + 457, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1938.) Price 30*s*.

KILN-SEASONING TREATMENTS OF TEAK AND THEIR EFFECTS ON ITS WEARING QUALITIES AS FLOORING. By R. A. G. Knight, B.Sc., A.M.I.Mech.E., A. R. Dean, and F. H. Armstrong M.Sc., A.M.I.Mech.E. Department of Scientific and Industrial Research, Forest Products Research Records, No. 23. Pp. 14, $9\frac{3}{4} \times 6$. (London: His Majesty's Stationery Office, 1938.) Price 6*d*.

MINES REGISTER. Successor to The Mines Handbook and The Copper Handbook. Volume XIX. 1937. Pp. 282a + 1340, 9 × 6. (New York: Atlas Publishing Company, Inc., 1937.) Price $25.00.

BULLETIN OF THE IMPERIAL INSTITUTE

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THE WORK OF THE IMPERIAL INSTITUTE

By Sir Harry Lindsay, K.C.I.E., C.B.E.
Director of the Imperial Institute

The substance of an address delivered at the Country Conference of the Chartered Institute of Secretaries, held in Edinburgh on May 18, 1938. Taken with kind permission from *The Secretary* of July 1938, which contains a verbatim report of the address and discussion.

I want to tell you first of the need for an organisation like the Imperial Institute; I want to tell you secondly the work that we do to try and justify our existence and meet those needs; and thirdly I want to try and draw some conclusions.

To take first of all the need for an Imperial Institute, especially in its relation to Empire trade, we must remember that trade to-day is a battleground. I hope, we all hope, that we are getting past the stage when war is a matter of high explosives. We do not yet seem to be past that stage, but we are surely approaching a time when war is more a matter of economics than of actual physical violence, and in any case we have to make our preparations, not only for physical warfare, but also for the warfare of trade; and trade is a warfare not only in the international but also in the national sphere. Within the country itself there is the struggle of competition, a constant pull between producer and consumer, buyer and seller. How much more so between different countries, even countries within the Empire. Now that competition, that pull, is concealed. The producer and consumer are very rarely at such close quarters that they see each other, for the developments of trade under technical organisation are such that a large number of middle-men, links in the chain of trade, intervene between producer and consumer; and, when we talk, as I am doing this morning, on the subject of Empire trade, of course we recognise that in this field producer and consumer are still further apart. There is the overseas primary producer—he is the man that I have most at the back of my mind—then there is the exporter or shipper; then the carrier, or merchant steamship line; there is the importer on this side, and next after him the broker, the distributor, the actual seller, and so you ultimately come down to the consumer.

Now, it stands to reason that if the consumer is to get what he wants at the price he is prepared to pay for it, he must rely on the retail merchant and so on back along the chain, and although he must exercise in his own political interests a preference for the Empire producer, that preference is apt to vanish or become very thin if quality and price are not right. I propose, however, to put politics altogether aside in this talk; not to discuss preferences for Empire producers because they are Empire producers; not to discuss tariffs or preferences at all. They do not come into our purview at the Imperial Institute except so far as the Import Duties Advisory Committee consult us, and even so we advise them strictly on the technical or market conditions. So let me state my case in this way:—It is necessary to have an organisation at the centre of a great Empire like this which will be able to advise the Overseas Empire primary producer on the strict facts of the case—what are the market requirements, how is he meeting them, can he meet them better by reducing his price or by raising his quality? You must have some central organisation which can carry out that task because—well, you know what it is yourselves. What does the retailer say to the wholesale merchant and what does he say to the broker and what does he say to the importer and what does he say to the exporter at the other end, and what does the exporter say to the primary producer? It all comes back to the primary producer in a very curt report indeed, "My dear friend, you must cut your price or we shall not do business," or "My dear friend, your packing is altogether hopeless; you must improve your preparation for the market or else we cannot do business," or "You must improve your quality or you cannot do business." Those of you, I am sure, who are interested in overseas trade must have seen many of these reports, and that is exactly the sort of report which is most discouraging in its effects on the primary producer in the Overseas Empire. What can he make of it? How can he reduce his price? How can he raise his quality? How can he improve his packing for the United Kingdom market? Now that is precisely where we come in. We do our very best to translate those brief curt criticisms of the United Kingdom merchant into terms which are really intelligible, really encouraging, not discouraging, to the overseas primary producer, and give him a real idea what concrete action he must take in order to reach this market with a minimum of loss and a maximum prospect of success. That is the first need, I think—the need of a central organisation, or institution, to furnish reports of this kind.

Now, all this question of prices and qualities is really in essence a question of scientific analysis and report. It is quite true that in our central colonial institution at South Kensington we have put up a large and handsome building and that we exhibit specimens of Empire goods. We have done all that; but there was this wisdom in the foundation of the Imperial Institute in 1887—that it was even then recognised how essential a part of a central institution must be played by laboratories and intelligence offices in which specimens of overseas products can be analysed and reported on as well as reports given on market conditions. The scientific handling of these problems is absolutely essential; we must be fully equipped with laboratories to be able to conduct technical analyses and investigations of the raw materials of the Empire. That is the first requirement of a central organisation such as ours, if we are to carry out our proper functions in the interests of Empire trade.

Now I turn to the second requirement, that of technical information. If you want really to find out something fundamental in the scientific field to-day it is not enough to consult any single authority. It is not even enough to go to a text book. You must have patience and take trouble and time to hunt through all the specialist journals in all languages in order to arrive at the very latest scientific information, and that, of course, requires a central organisation like the Imperial Institute with its technical library, supplemented by its statistical offices, its indexes and its expert staff skilled in foreign languages and able to tell the scientist where to look for a particular scientific article or treatise. I think that conclusion is self-evident. I do not need to develop it more.

Now, if there is the need for all that help on the scientific side, there is also another side, another need which only a central organisation can supply, and that is the less imposing but lighter side of publicity. It is not enough nowadays to go on grinding out scientific information or answering technical questions. You must at the same time tell people what you are doing. It is obvious, it is forced on us, and where can that information be given more profitably than to the minds of the younger generation ? While we may talk, or try to talk, pure science to the scientist, it is equally important that in talking to the rising generation we must present the Empire to them with the finest admixture we can give of science and art, and thus appeal to their imagination and their sense of adventure. Every human being is an admixture of the artist and the scientist, only in some the artist predominates and in others the scientist. It is very valuable therefore that there should be one institution which is able to tell the rising generation scientific things artistically.

Now I come to the second part of my talk, the work of the Imperial Institute ; that is to say, how do we try and fulfil this rôle which has been imposed on us ? I am going to sketch this very briefly. We began in 1887, with the laying of our foundation stone by Queen Victoria, as the nation's gift to that great Queen in commemoration of her golden jubilee. The next date I take is six years later, 1893, when the Imperial Institute was opened. It is really rather a fine building, though occasionally we regret that it was placed in museum-land, because it is really not a museum at all. We rather think of it as a central clearing house of information, technical and artistic, about the Overseas Empire. In six years again, in 1899, it was unfortunately hopelessly bankrupt and the reason for that was not lack of interest, because everybody was interested in it. People went there because they were interested in its technical work and in studying the exhibits and so on; and there were spacious halls and all the facilities of a club, but unfortunately there was not the money to continue it on its original foundation because the £400,000 which was put up for the Imperial Institute, by most of the Governments of the Empire, was expended in the proportions of £250,000 on the building and £150,000 on the endowment. The figures ought to have been reversed and perhaps even more than reversed. Nevertheless, the result of our bankruptcy was all to the good. The United Kingdom Government stepped in and took over the building and handed over half of it to the London University, and we were supplied with funds to enable us to carry on. That was long before my time, of course. The United Kingdom Government's example was followed by the Dominion and Colonial Governments, and the Imperial Institute started again with revived vigour.

In 1929 came the slump. The Dominion Governments, alas, were not able to maintain their contributions and one by one they dropped out. Now comes the interesting part of the story. By 1933-34 the finances of the Institute were reduced so much that its future became uncertain. However, the Colonial Governments learned of this, and every single Colonial Government doubled its contribution to the Institute. That is an illustration of what I was saying, how valuable our work is to the primary producer, especially in the Colonial Empire. The United Kingdom Government also increased its contribution, and now I am glad to be able to say that the Dominions are coming back. South Africa has restored her grant, New Zealand and Australia are contributing again, and so is Newfoundland. Burma has been a contributor since her inauguration as a separate government last year. The Southern Rhodesian Government has always supported us. Canada supports our Empire Film Library and India maintains the Indian Court in our exhibition galleries. We hope that all Dominion governments will shortly rally to the support of all our activities at the Institute.

That is a picture of our development since the Institute was founded in 1887. My short account of the work we do will fall into two parts. In the foreground is our technical and scientific work; and the background is artistic, the representation of the life and scenery and industries of the Overseas Empire for the benefit of the rising generation. In our laboratories we investigate the products of the Overseas Empire and send reports both to producers and exporters overseas and also to importers, manufacturers and consumers at home. We send market reports as often as necessary and we work in very close touch with government offices like the Department of Overseas Trade, the Colonial Office, the new Colonial Empire Marketing Board, and so on. In our circulation of Empire films we co-operate closely with the Public Relations Officer of the General Post Office. We publish statistics, technical monographs, and our quarterly bulletin. I do not want to go into any details of what we do on the scientific side. I should like just to give one illustration of the sort of work that is done. It is an illustration which comes home particularly to this audience because the inquiry emanated from a manufacturing organisation in this country. There is a quick-drying oil, tung oil, which is highly valued for paint manufacture, and the paint manufacturers came to us and said that they were then dependent entirely on China for their supplies of tung oil, and asked whether it could be produced within the Empire. With the co-operation of Kew, and the Research Association of British Paint, Colour, and Varnish Manufacturers, the seed was obtained from China and was sent out to many Dominions and Colonies where they were likely to be able to grow tung-trees; and in the result there are some Dominions and Colonies which have found they can grow tung successfully. It is being grown in Kenya, in Nyasaland, in South Africa, in Assam, in Burma, in Australia, and in New Zealand. Then arose some very technical questions relating to the extraction of the oil. We have been able to help there, too, with the help of British oil crushers and machinery manufacturers. We are now able to recommend a machine which will do the job. I should explain that the tung fruit is about half the size of one's fist, and has a particularly fibrous shell. Inside that shell you find five nuts grouped. You extract these nuts and it is the crushing of the nuts which yields this quick-drying oil. We have encouraged not only the planting and cultivation of the trees with the help of the Director of Kew Gardens, but also the manufacturers of the machinery for the extraction of the oil, and finally also the marketing of the kernels and the oil in the United Kingdom. That, I think, is a good example of the help that can be given to Empire production and trade by an organisation like ours.

We have got the contacts and the experience to enable us to collect the knowledge required if necessary from other countries. We have put all that knowledge at the disposal of the Empire producer overseas ; and remember that although a great deal of the work we used to do is now done by the High Commissioners and Trade Commissioners of the Dominions and also of the Colonies, these officers are not able to command in quite the same way all the sources of supply and information which are at the disposal of the Imperial Institute. Ever since 1893 all sorts and conditions of Empire products have been passing through our hands. We have got it all recorded and maintained to date with the help of expert authorities, both official and unofficial, on our own index-cards and in our library, and therefore we are able to perform these functions much better than a single representative of a single overseas Empire country. There was a very interesting case the other day. It came to our notice that British manufacturers of certain composition plaster boards, used for heat and sound insulation, were using increasing amounts of an interesting mineral called vermiculite, but that supplies were all coming from the United States. Our mineral department thought that Empire supplies ought to be available but had probably been overlooked as the mineral looks much like a worthless mica. We therefore wrote to all Empire countries where the mineral might be found and as a result we received samples of likely material. These were tested and the most promising were submitted to possible users in Great Britain. As a result very promising vermiculite is available at competitive prices from the Union of South Africa and Tanganyika, and it is possible that Uganda will also be able to enter the market. It is a useful service we have been able to perform, because we are certain that more will be heard of this new mineral before very long.

Then there are a large number of products for which we depend almost entirely on foreign countries for supplies, such as olives, sulphur, camphor, rosin, turpentine. We are doing our best to advise on new possibilities of production within the Empire. There is, for instance, a plant recently reported to us from the Sudan which contains a high proportion of camphor and which may be valuable as an alternative source of supply to Japanese or to synthetic camphors. Then, of course, there are well-known Empire products which are susceptible of improvement and there we advise, and have recently advised with great success, on the subject of the preparation of Empire hides and skins for the leather trade, nutmegs from Grenada, beeswax, and so on. Materials thrown away in the bad old days as useless are now used; for example, coconut-shell is now used for the manufacture of charcoal in connection with gas masks.

Now, I turn to the other side of our work, namely the educational facilities which we offer at the Institute for visits of school parties and school children to the Institute. That is an equally important and fascinating part of our work. It is a grand thing to see these school parties coming round. Of course it is the London children who are best qualified to take advantage of these facilities, and the London County Council educational authorities do respond very well indeed, and send us large parties of scholars. We have had between half and three-quarters of a million souls passing through our Galleries in a single year. Last year the figure was over 600,000 and by far the largest proportion of them of course were school children. We have four great Galleries running west, east, south, and north, and we arrange them geographically so that the East Gallery shows India, Burma, and Ceylon, and the West Gallery, Canada. From Ceylon, our visitors pass to Aden, Somaliland, the Anglo-Egyptian Sudan, East Africa, South Africa and West Africa, all in the North Gallery; thence by the Mediterranean Colonies to Canada; thence to the South Gallery—Newfoundland, the West Indies, Falkland Islands, New Zealand, Fiji, Australia, Hong Kong, Borneo, Sarawak, Malaya, and so back to India and Ceylon again and they have been a tour of the Empire.

There was a small boy who once remarked very sagely that when a man is wrapped up in himself he makes a very small parcel. There is a wealth of wisdom in those words, because the chief function of education really is to enable one to develop the capacity to throw one's mind outwards, outside of one's own parochial or personal interests, out towards the interests of other people; to the interests of the outside world; and therefore *a fortiori* to the Empire world, where you are certain of a welcome, and where there is so much in common between yourself and your kith and kin of the Overseas Empire. That is the principle on which we work. Too many people are "inverts" and feel most at home within themselves; but nevertheless man has that faculty for throwing his mind outwards, and that faculty is an essential part of his make-up; and that is the faculty which the school teacher tries to develop.

Most school teachers when they send their school parties to the Institute send them with a definite lesson in view. It may be one definite Dominion or Colony or a group of Colonies, it may be textiles of the Empire, minerals of the Empire, the story of tin, the story of rubber, and so on; whatever it is, our guide-lecturers take the school parties round and lecture to them on the required subject. Accordingly, the Imperial Institute has become what you might call from this point of view a Storyland of the Empire. We tell the story of the Empire by means of the exhibits in our Galleries; and we have gone further than that. We are, as fast as we can, discarding the dreadful old-fashioned method of display by which, when you showed the products of a country, you simply took, say, a handful of rice and put it in a bowl and put the bowl on a shelf and wrote "Rice" underneath in large letters. That is hopeless, and equally bad was it to take three bowls and to write: "Rice, Grade 1," "Rice, Grade 2," and "Rice, Grade 3." Nobody visiting the Galleries and seeing those old-fashioned exhibits was really any better off than before, especially as the London market so frequently confuses the grades so that grade 3 is sometimes the best and sometimes grade 1 is best and you do not quite know which is which. Well, now we are trying to tell these stories of primary products of the Overseas Empire as we feel they ought to be told; that is to say, in sequence from the raw material to the finished goods, so that the child's mind comes to rest at the end of the story on some simple object of domestic life which it knows and recognises. That is the essential feature of our stories. We do not bother in the slightest about trade marks or grade marks or anything like that. If the story ends up with some well-known proprietary soap or face-cream or food or drink, so much the better. If a child spots a packet of tea or margarine in a well-known wrapping so much the better.

Its attention is attracted by something that it recognises and it anchors its mind on that; so it is encouraged to work backwards from the recognised and finished product to the raw material which was its source. We work forwards but the child's mind works backwards. We finish our exhibit with something which the child recognises, and it asks itself: "What is this object? What was it made of? How do you make it? What machinery did you use? What processes did it pass through?" and, of course, all the time, "Where did it come from? Who are the people who cultivated or felled or mined this raw material?" from which you find that your coat buttons (or whatever it is) are made. That is the right way to tell the story of the economic geography and the commercial connections of the Overseas Empire. One by one with the help of the manufacturers we are beginning to tell these stories. We are telling them by means of photographs showing exactly how the object is mined or felled or produced and the stages through which it passes to its final form. You have only got to see two or three of these stories to convince yourself that there is a great deal of information available in the Galleries of the Imperial Institute, which even an audience as distinguished as this does not know. The latest story which we have put together is that of bauxite and aluminium; and here the ramifications are enormous.

Then again we try to put up something interesting in the way of a caption over each exhibit. One of the most difficult exhibits we ever had to deal with was wool, because wool is the most uncompromising substance in the world. It is wool and nothing else. Well, after a good deal of thought we started off in this sort of way: "Falkland Islands Wool. How many socks does a sheep wear?" The story goes on to show exactly how much wool comes off one sheep's back. There it is, about 7 lb. weight. The next stage is: "What does it look like when it is scoured and cleaned?" It comes down from 7 lb. to 4 lb., but there are by-products; there is grease, and the grease that comes out of the wool makes lanoline and you know all about lanoline because it is always used in every home. Then we go on to distinguish between the short fibres of wool and what they make in the way of felts, etc., and the long fibres which go to be spun. They are drawn out and twisted ever so often until they pass into the finest yarn and then we show the range of products from that. We finish up with a pair of socks and the final label runs: " Your mother can knit 26 pairs of socks out of the wool that came from one sheep's back."

Before sitting down I should like just to draw one or two conclusions from this survey of the work we do. It is intriguing work because we feel that there is something behind it, something of rather bigger importance than trade, though trade is a big enough subject by itself. I was rather amused the other day by an incident which occurred after I had concluded a talk to a college audience on the subject of Empire Service. After the talk, questions were encouraged. One young woman got up and said: " This is all nonsense that you have been saying to us about the spiritual values of the Empire. It is only a matter of trade." That was rather a conundrum. The Empire is really held together in spite of all the things that do not usually hold Empires together, in spite of differences of climate, differences of language, differences of race, differences of colour, differences of religion and creed. Our Empire is the whole world in miniature, and there must be some vital principle running through the whole Empire and uniting it in spite of all these differences. What is that principle? Well, of course the immediate answer is the Crown. Of course it is the Crown. It is the Crown which holds the Empire together. But we must go a little deeper than that. Why and how does the Crown hold us together? It is because the Crown stands to us for something which is essentially British, something which is fundamental to the spiritual make-up of each one of us. Apart from any question of administration, the Crown typifies to us a certain attitude of good-will and fellow-feeling, so that we know that when we deal with so and so, at any rate the betting is in favour of our getting a straight deal. That is what the Crown stands for, and there are a number of other characteristics which I think the Crown stands for besides, of integrity and soundness and single-mindedness.

But to return to my lady questioner. I hope you will agree that I was right when I told her that there was nothing irreconcilable between the spiritual and the commercial. In fact, apart from the world of nature, the only way in which the spiritual can reveal itself is through the ordinary processes of human thought and human relationships, of which one of the most important is commerce. If you are in commercial relations with some overseas market and you find yourself fairly treated, you say to yourself, here is an example of honest dealing between one merchant and another; and if the essential value of that relationship is not a spiritual value, then I do not know what it is. And the whole point of trading within the Empire is that you have the best *a priori* chance of getting a square deal from somebody whose outlook is fundamentally similar to your own.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Indian, and Colonial Governments

CHAULMOOGRA OIL FROM MAURITIUS

THE importance of producing in various parts of the Empire local supplies of chaulmoogra oil for the treatment of leprosy was mentioned in an earlier issue of this BULLETIN, 1936, 34, 145, where reports were published on the results of examination of samples of seed of *Hydnocarpus wightianus* and *H. anthelminticus* grown in Nigeria, Ceylon, and Malaya. In September 1937, three samples of oil prepared in different ways from the seeds of *H. wightianus* were forwarded to the Imperial Institute by the Director of Agriculture, Mauritius. It was desired to ascertain the quality of the oils in comparison with the *H. wightianus* oil which is at present employed in the treatment of leprosy, and which comes in the main from India.

The three samples were stated to have been respectively prepared by (1) expression, (2) extraction with ether, and (3) extraction with petroleum ether. They consisted of soft fats, of greyish-cream colour with a very slight greenish tinge. The odour of the expressed sample was slight and characteristic; that of the fat extracted by ether was reminiscent of the solvent, while in the case of the sample extracted by petroleum ether the smell was characteristic of oils extracted by this solvent.

On melting the samples, the resulting oils were very slightly cloudy. On heating the two samples prepared by solvent extraction, inflammable vapour was evolved, indicating that the fats were not completely free from solvent.

The samples were further examined with the following results, which are shown in comparison with the requirements of the British Pharmacopœia for *H. wightianus* oil:

	Expressed oil.	Ether-extracted oil.	Petroleum-ether-extracted oil.	Requirements of the British Pharmacopœia.
On oil as received—				
Loss at 50° C., *per cent.*	0·14	0·50	0·53	—
On oil filtered through paper at 100° *C.—*				
Specific gravity at 25°/25° C.	0·9566	0·9550	0·9550	0·950–0·960
Melting point . .	23·0° C.	23·3° C.	23·5° C.	20–25° C.
Specific rotation at 20° C.	+57·0°	+56·1°	+55·25°	+53° (min.)
Refractive index at 40° C.	1·4743	1·4741	1·4741	1·472–1·476
Acid value . . .	1·7	1·7	0·7	25·0 (max.)
Saponification value .	203·6	201·3	199·3	198–204
Iodine value (Wijs, ½ hr.)	99·4	98·6	98·3	97–103

According to the British Pharmacopœia, *H. wightianus* oil is partially insoluble in cold alcohol (90 per cent.), almost wholly soluble in hot alcohol (90 per cent.), and miscible with ether, with chloroform, and with carbon disulphide. The present samples conformed with all these tests with the exception of the solubility in hot alcohol. In this latter case the samples were more soluble in hot than in cold alcohol, but it would not be correct to state that they were "almost wholly soluble" in hot alcohol.

This relatively limited solubility of the samples in hot alcohol may be due to their very low acidity, the presence of appreciable amounts of free fatty acids having a tendency to increase the solubility of oils and fats in this solvent. The British Pharmacopœia will pass a *Hydnocarpus* oil with an acid value as high as 25, and such an oil would be expected to be more soluble in hot alcohol than any of the present samples, the acid values of which ranged only from 0·7 to 1·7.

From the foregoing results it will be seen that the three present oils yielded analytical figures falling within the ranges specified in the British Pharmacopœia. Their solubilities would also probably be considered satisfactory, notwithstanding what has been pointed out above in respect of the solubility in hot alcohol, but as the British Pharmacopœia lays down that official *Hydnocarpus* oil is obtained by *cold expression* from the fresh, ripe seeds of *H. wightianus*, of the three samples now under report the expressed oil is the only one which could fully meet the official requirements, provided that the expression was carried out in the cold.

Although expressed *H. wightianus* oil is official in the United Kingdom and there is, therefore, a preference for oil prepared by this method, it appears *prima facie* that oil prepared by solvent extraction, if completely freed from traces of solvent, should prove of equal value in the treatment of leprosy. Clinical tests would, however, be necessary to determine this point.

The two present samples obtained by extraction with ether and petroleum ether still contained traces of solvent, and in preparing the oil by the extraction process care must therefore be taken to ensure freedom from solvent. This may be effected by thorough heating of the oil in vacuo, with or without the use of steam.

THE ACTIVE PRINCIPLE OF KURJAN SEED (*MYRSINE AFRICANA*)

THE sample of "Kurjan seeds" which is the subject of this report was forwarded to the Imperial Institute by the Crown Agents for the Colonies in April 1937. The material had been received by the Crown Agents from the Government of British Somaliland, with the request that it might be examined with a view to the determination of the active principle.

It was stated by the Senior Medical Officer, Burao, British Somaliland, that these so-called seeds (known as "kurjan" by Somalis and "kachamoo" by Ethiopians), although actually obtained from Ethiopian refugees in Borama, British Somaliland, are collected from an evergreen shrub growing in the hills near Jigjiga, Abyssinia. They are a popular vermifuge used largely for tapeworm infestations, being taken regularly as a prophylactic in a heavily infested population. For this purpose the "seeds" are lightly beaten to remove the husks and the cleaned whole kernels are swallowed with water, or, preferably, with tea without milk. The dose is about one ounce.

On the evidence of herbarium specimens received subsequently, the material was identified at the Royal Botanic Gardens, Kew, as *Myrsine africana* L. (N.O. *Myrsinaceae*).

The material received consisted of dried fruits, about one-third of which still retained their thin fleshy mesocarp; the remainder possessed a thin brittle endocarp enclosing a horny kernel with a reddish-brown testa. The latter kind were spherical, up to 0·15 in. in diameter and varied in colour from yellowish-brown to reddish-brown; the whole fruits measured up to 0·2 in. in diameter and were very dark reddish-brown in colour with a wrinkled surface.

A preliminary examination of the material showed that it was free from cyanogenetic glucosides, saponins, and principles of an alkaloidal nature. The fruits were found to contain 3·8 per cent. of ready-formed reducing sugars (expressed as dextrose) and 0·2 per cent. of sugars reducing only after inversion (expressed as sucrose).

As Krishna and Varma [1] had previously examined the fruits of *Myrsine africana* and had found embelic acid and quercitol present (3 per cent. of the former and 1 per cent. of the latter), a comprehensive investigation was carried out on the whole sample as received to determine whether these same compounds could be isolated therefrom. The method of Krishna and Varma was followed.

The ground " seeds " were allowed to stand in the cold with petroleum ether for two days to remove the fatty oil and other petrol-soluble bodies. The " seeds," after separation from the petroleum ether extract, were freed from the solvent by exposure to the air. The material removed by the petroleum ether was a reddish-brown liquid from which a slight amount of solid matter separated out on standing. The yield was 4·3 per cent.; it was not further examined.

The fat-free " seeds " after being air-dried were extracted in a Soxhlet extractor with chloroform for 13 hours. After removal by distillation of the bulk of the solvent from the extract small reddish-orange crystals separated out. These were removed by filtration. A further crop of similar crystals was obtained on further concentration of the mother liquor. The total yield of unpurified crystals was 4·8 per cent. These reddish-orange crystals were purified by repeated crystallisation from alcohol and the final product melted at 145° to 146° C. A benzoyl derivative was prepared from this substance, which after re-crystallisation was found to have a melting point of 97·5° C.

The melting points of embelic acid and its benzoyl derivative have been recorded as under:

Melting Point of Embelic Acid

143°-144° C.	Krishna and Varma [1]
142° C.	Kaul, Ray and Dutt [2]
140° C.	Warden [3]
143° C.	Hasan and Stedman [4]
142° C.	Heffter and Feuerstein [5]

Melting Point of Di-benzoyl Derivative of Embelic Acid

95°-96° C.	Krishna and Varma [1]
97°-98° C.	Kaul, Ray and Dutt [2]
98° C.	Hasan and Stedman [4]
97°-98° C.	Heffter and Feuerstein [5]

The reddish-orange crystals isolated from the present sample of *M. africana* " seeds " had the properties and gave the reactions which are shown below, in comparison with those of embelic acid (Kaul, Ray and Dutt [2]) :

	Found.	Recorded.
Solubility in—		
Water . . .	Insoluble	The same.
Alcohol . .	Fairly soluble	Do.
Ether . . .	Fairly soluble	Do.
Chloroform . .	Fairly soluble	Do.
Heated on platinum foil—	Melts, chars and burns with a yellow non-sooty flame.	Melts, swells up, chars and burns with a yellow, non-sooty flame.
Reactions—		
Dilute caustic soda.	Dissolves giving a greyish-violet solution.	The same.
Concentrated sulphuric acid.	Dark reddish-violet coloration.	Dark red coloration.
Alcoholic solution with :		
Neutral ferric chloride.	Dark reddish-brown precipitate.	The same.
Silver nitrate.	Brown precipitate.	Greyish-brown precipitate.
Copper acetate.	Dark green precipitate.	Brownish-green precipitate.
Lead acetate.	Greyish-green precipitate.	Dark green precipitate.

The above properties and reactions confirm that the reddish-orange crystals were *embelic acid.*

The residue left after the extraction of the "seeds" with petroleum ether and chloroform was air-dried and extracted with 90 per cent. alcohol in a Soxhlet extractor for 18 hours. The alcoholic extract was concentrated and allowed to crystallise. The crystals were filtered off, washed with alcohol and boiling chloroform ; then dissolved in hot water and the solution allowed to crystallise. After repeated crystallisation a colourless crystalline substance melting at 231°-233° C. was obtained. This substance would appear to be quercitol. It was soluble in water and did not reduce Fehling's solution even after boiling with acid. Owing to the very small amount of material available no further examination of this substance was carried out. The yield of quercitol was about 1 per cent.

The melting point of quercitol has been recorded as under :

228°-230° C.	Krishna and Varma [1]
235° C.	Richter [7]
230° C.	Mueller [8]

Conclusions

The results of the investigation show that the present sample of *M. africana* " seeds " contains embelic acid (4·8 per cent.) and quercitol (about 1 per cent.), both of which constituents have previously been found by Krishna and Varma in a sample from the United Provinces, India.

The anthelmintic properties of kurjan "seeds" are thus evidently due to the presence of embelic acid. This acid also occurs in the berries of *Embelia ribes* (Warden [3], and other observers), which are used in India as an anthelmintic, and its presence is stated to be responsible for this property (Hasan and Stedman [4]). According to the *Pharmacographia Indica* [6] the ammonium salt of embelic acid is also effective as an anthelmintic, but it has probably never been used to any great extent (Hasan and Stedman [4]).

No anthelmintic properties are ascribed to quercitol.

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ZEBRA HIDES FROM KENYA

A CONSIGNMENT of sixty zebra hides was sent to the Imperial Institute by the Chief Veterinary Officer, Kenya, in May 1937, with a view to ascertaining their market possibilities.

The consignment consisted of the following:

(*a*) A few hides of black and white hair, with necks and shanks complete.
(*b*) Hides of black and white hair, with necks and shanks removed.
(*c*) Hides of brown and white hair, with necks and shanks complete.

All the hides showed rather poor flaying, the flesh side exhibiting undesirable cuts. The flay was, however, normal for game hides. Grubs of the hide bettle were present on the hides and had caused some slight damage.

The consignment was divided into two lots, one consisting of 55 hides and the other of five hides. These were submitted to tanning trials by two firms, whose reports are summarised below:

(*a*) 55 *Zebra hides.* " The lot was not satisfactory because it contained too many hides with bad holes in the centre. Furthermore, sunburnt hides were present, which crack, and also moth-eaten ones which are entirely inferior. A number of hides showed deep cuts. In future consignments it would be necessary to grade the hides according to a strict collection as follows: *Number Ones* should be well taken off, clean, without cuts or even slight cuts, without damages, only small holes at the edge of the hide being permissible. *Number Twos* would be hides with bad cuts, also moth-eaten ones with not more than three small holes in the middle. *Number Threes* would be sunburnt hides with large holes, and/or badly moth-eaten.

" The value of the Seconds would be two-thirds and of the Thirds one-half that of the Firsts."

(*b*) 5 *Zebra hides.* The tanner reported that the drying of the hides had not been satisfactory and had caused putrefaction. Attention was drawn to the peculiar formation of the leather, two distinct layers being present, and that the penetration of the tanning material was slow. The hides were considered unsuitable for the manufacture of sole leather.

The leather produced in the above tanning trial (*b*) was submitted to microscopical examination by the British Leather Manufacturers' Research Association, who kindly furnished the following report:

" We have examined the bend of zebra hide leather. The appearance of a 'two-layer' formation is caused by the abrupt change in structure of the hide from grain to corium, the upper 'layer' being the grain, and the lower the corium.

" Our examination would confirm the tanner's opinion that the hides are not suitable for sole leather. Our opinion is that the grain with its fine structure has a lower resistance to abrasion than has the corium, and in this leather the grain is very deep.

" Owing to its similarity to the 'shell' of horse hide, zebra hide might be tanned for the same purposes as those for which the 'shell' of the horse hide is used. We think that if the hide were split the grain might be suitable for leather hand-bags and such articles, while the compact structure of the corium might render it suitable for purposes for which the flesh split of ox-hide is used to-day—for instance, cheap insoles."

The detailed results of the examination, as furnished by the Research Association, were as follows:

(1) *Cross section of the leather at a position about* 6 *in. from backbone and* 12 *in. from britch—i.e. near hip region, called the " shell " region in horse hide.*

The grain occupies a considerable portion of the total thickness of the leather, and there is a very abrupt transition from grain to corium. Towards the corium there is a fairly wide region of very finely split-up grain fibres. At the junction of grain and corium the fibres of the corium in some cases turn back into the corium, and in others show a sudden splitting up to form this finely split-up grain region. The weave pattern in the corium is very regular and compact; the angle of weave is medium, rising towards the grain, and the fibre bundles have a small diameter in comparison with heavy hides such as ox-hide. The fibre structure is very similar to the " shell " of horse hide.

(2) *Cross section of the leather at a position about two-thirds of the distance along the bend towards the shoulder.*

(3) *Cross section of the leather at the shoulder edge of the bend.*

The fibre structure at both of these positions was very similar to that at position 1 (hip region), the main difference being that the grain is thinner in the middle of the bend than in the hip region, and thinnest at the shoulder. The difference in depth of grain appears to be due to the fact that the finely split-up region of the grain which occurs just above the junction of grain and corium is present to a less extent towards the middle of the bend than at the hip region, and is apparently absent at the shoulder edge. The junction of grain and corium at the latter position is less abrupt than in the other parts examined, and is comparable as regards the merging of grain and corium to ox-hide.

The fibre structure of the corium of the shoulder edge is rather more split up than that of the hip region, and the same is true, to a smaller extent, of the fibre structure of the middle of the bend, but no such difference as that recorded between the "shell" and front portion of horse hide was observed between the three parts sectioned in the examination of this zebra hide.

Conclusions

The zebra hides were inspected in the raw condition by the Imperial Institute Consultative Committee on Hides and Skins, and on completion of the tanning trials and the investigation of the leather, the results, together with specimens of the leather, were considered by the Committee, whose observations and recommendations were as follows:

Certain well-marked parts of the zebra skin are used with the hair on for bags and upholstery. The parts concerned are the neck, skull and shanks, and the colours of the hair must be black and white. There is a limited market for such fancy skins, which realise about 30*s.* each for the complete skin at the present time. In the lot of skins submitted for examination these relatively valuable parts had been removed from most of the skins.

Skins from which the parts specified above have been removed, or complete skins of other colours than black and white, are suitable only for leather production. Despite the peculiarity of composition and the difficulty encountered in splitting them, they can be utilised by the tanning industry. There is a market for them in the United Kingdom and a readier sale for them in America or on the Continent as low-quality hides. At the present time, with cattle hide prices at a low standard, zebra hides would realise about 4½*d.* per lb. In general the sale of zebra hides would be easier in times of high prices for cattle hides.

In the past an obstacle to building up a steady trade in zebra skins has been the possibility of fluctuating restrictions regarding killing. For instance, the destruction of zebra has been permitted when they became too numerous, and prohibited when the numbers decreased. In order to secure a ready market for zebra skins consumers must be assured of commercial quantities being steadily available. At the present time supplies are irregular.

In preparing the hides for the market care should be taken to avoid cutting the skin in flaying, and the drying should be carried out by one of the approved methods employed for cattle hides.

SALTS AND BRINES FROM CEYLON

The sale of salt in Ceylon is a Government monopoly, and though the bulk of the production in the Island comes from privately-owned lagoons and tanks, particularly on the south and west coasts, the Government operates two large salterns, one at Elephant Pass in the extreme north and the other at Palavi on the west coast.

The salt produced by private enterprise under licence is purchased by the State, payment being made for three-fourths of the salt as harvested and for the remainder after the whole has been stacked and weighed.

Hitherto the output has consisted largely of common salt, but experimental work having demonstrated that other products such as refined salt, magnesium sulphate, muriate of potash, caustic soda, and bleaching powder could be successfully prepared from the salt liquors, a scheme has been put in hand for the production in Ceylon of these chemicals, most of which are at present imported into the island.

In connection with the experimental work mentioned above, a number of samples of crude salts and residual liquors from the salterns were sent for investigation to the Imperial

Institute, by the Acting Salt Adviser, and it was subsequently learned that certain processes which had been suggested by the Institute for the purification of impure magnesium sulphate and for the enrichment of low grade potash salts had proved successful in practice.

The following summary of the investigation which was carried out at the Imperial Institute may be of interest to producers of sea-salt in other parts of the Empire.

Description of Samples

The samples received were as follows:

A.—One Winchester bottle containing about 2½ litres of brine of 35° B.—specific gravity approximately 1·3—stated to have been obtained from the Government Saltern at Elephant Pass by solar evaporation of bittern reading 30° B. discarded from the crystallisers for common salt.

The sample as received was a colourless liquid with a considerable amount of separated salts.

B.—Specimen of magnesium sulphate stated to have been obtained simply by artificial refrigeration of the 35° B. brine, and subsequent drying of the solid material separating out. It was pointed out that in this state it was not sufficiently pure to comply with the requirements of the British Pharmacopœia, and it was therefore desired to find a means of improving the product involving as little additional cost as possible.

The sample as received consisted of a mass of white crystals, rather sticky in places.

C.—A specimen of mixed salt obtained by artificial evaporation of the decanted liquor after precipitation of the magnesium sulphate by refrigeration.

This sample was stated to have been obtained by boiling the decanted liquor from which the magnesium sulphate was precipitated until the liquor had a specific gravity of 37° B. when tested hot. Advice was desired as to whether it could be used as a substitute for imported "muriate of potash," or if it could be rendered more suitable for this purpose by simple means.

The sample as received consisted of a mass of small white crystals.

D.—Balance of liquor after precipitation of the mixed salts.

This was the liquor remaining after the above operations. The sample as received consisted of one Winchester quart bottle filled with a colourless liquid and a considerable amount of separated salts.

Results of Examination

The samples were analysed with the results shown in the following table:

TABLE I

		A	B	C	D
		Grams per litre.	*Per cent.*	*Per cent.*	*Grams per litre.*
Insoluble in water		—	—	0·01	—
Calcium	Ca	0·3	0·10	Nil	0·9
Magnesium	Mg	93·2	9·45	7·49	120·3
Sodium	Na	12·2	1·26	5·89	3·8
Potassium	K	13·0	0·20	9·44	3·6
Sulphate radicle	SO_4	68·1	35·19	0·70	41·8
Chlorine	Cl	242·8	3·17	38·34	312·6
Bromine	Br	4·6	0·02	0·31	6·8
Water at 200° C.		—	44·64	—	—
	Total	434·2	94·03	62·18	489·8
Reaction		Alkaline	Alkaline	Faintly alkaline	Alkaline

HYPOTHETICAL COMBINATIONS

		A	B	C	D
		Grams per litre.	*Per cent.*	*Per cent.*	*Grams per litre.*
Calcium sulphate	$CaSO_4$	1·0	0·34	Nil	3·1
Magnesium sulphate	$MgSO_4$	84·5	43·82	0·87	49·6
Magnesium chloride	$MgCl_2$	295·5	1·49	28·47	428·1
Magnesium bromide	$MgBr_2$	5·3	0·02	0·36	7·8
Sodium chloride	NaCl	31·0	3·20	14·97	9·6
Potassium chloride	KCl	24·8	0·37	18·00	6·8
Water at 200° C.		—	44·64	—	—
		442·1	93·88	62·57	505·0

The alkaline reaction appeared to be due, in all cases, to hydrolysis of magnesium chloride.

Sample A contained a considerable amount of solid salt which dissolved on warming the liquid to a temperature of 50° C. The specific gravity at 50° C. was 1·30, or 33·5° B. The analysis was made on the liquid after dissolving the separated salts.

Sample B was not homogeneous, as the chlorine content of two separate portions was found to be 2·91 and 3·62 per cent. respectively. The analysis recorded represents the average composition of the sample.

The last molecule of the water of crystallisation of hydrated magnesium sulphate, $MgSO_4.7H_2O$, is only driven off by heating to a relatively high temperature, sufficient to cause decomposition of the magnesium chloride, and the figure recorded in the table for water lost at 200° C. does not, therefore, represent the total amount of water present.

Sample C contained a considerable amount of water, which could not be determined directly, owing to decomposition of magnesium chloride on heating.

Sample D contained a considerable amount of solid salts, which dissolved on warming the liquid to a temperature of 60° C. The specific gravity at 60° C. was 1·325, or 35·5° B. The analysis was made on the liquid after dissolving the separated salts.

Trials for Improvement of Products

Sample B.—As indicated by the Acting Salt Adviser in his letter accompanying the material, the sample as received would not comply with the British Pharmacopœia standards for magnesium sulphate in respect of chloride and alkalinity. The fact that the sample was not homogeneous would also be a serious drawback to its commercial use.

After a number of preliminary trials, the following procedure for the purification of the material was found satisfactory :—A portion of the sample was added to water until no more magnesium sulphate would dissolve, and 1 per cent. by volume of sulphuric acid was added. A further portion of the sample was washed several times on a Buchner funnel with this acid solution and the resulting product, B1, was dried by suction at the pump. This material was found to be much purer than the original sample, but it still failed to comply with the British Pharmacopœia standards.

The product B1 was then washed several times with a solution of itself, prepared as above, but without any addition of acid, and the resulting product, B2, was dried by suction at the pump. The two successive washes with a solution saturated with respect to magnesium sulphate, dissolved from the crude salt the impurities, magnesium and sodium chlorides etc., with respect to which the washing solution is not saturated. Analysis of the product B2 gave the following results:

TABLE II

		Per cent.
Calcium	Ca	0·10
Magnesium	Mg	9·92
Sodium	Na	0·02
Potassium	K	0·05
Sulphate radicle	SO_4	39·15
Chlorine	Cl	0·03
Bromine	Br	Nil
Water at 200° C.		43·53
		92·79

HYPOTHETICAL COMBINATION

		Per cent.
Calcium sulphate	$CaSO_4$	0·34
Magnesium sulphate	$MgSO_4$	49·08
Magnesium chloride	$MgCl_2$	Nil
Magnesium bromide	$MgBr_2$	Nil
Sodium chloride	NaCl	Nil
Sodium sulphate	Na_2SO_4	0·04
Potassium chloride	KCl	0·06
Potassium sulphate	K_2SO_4	0·04
Water at 200° C.		43·53
		93·09

It will be seen that the quality of this material is very much improved in comparison with that of the original sample B. It complies with the British Pharmacopœia requirements for chloride, alkalinity and content of $MgSO_4$.

Owing to the alkalinity of the sample as received, it was found to be essential, in order to obtain a neutral product, to wash with a slightly acid solution at some point in the process. The use of a solution made acid with sulphuric acid in the first stage was found to be most satisfactory, any excess of acid being removed during the second stage.

This method as outlined should be quite satisfactory in giving a product of commercial quality and should not add unduly to the cost.

Sample C.—The amounts of sodium and magnesium chlorides in this sample are higher than occur in most crude potash-containing fertilisers. The low-grade potash fertilisers such as kainit contain, in addition to potassium chloride, a mixture of sodium chloride and magnesium sulphate, which would be less harmful than salts consisting of chlorides only. Crude potash salts containing up to 50 per cent. of sodium chloride can be used in agriculture, but the application of soluble chlorides, other than potassium chloride, in any quantity has been condemned, as it tends to cause a loss of calcium with no compensating addition of elements of manurial value. In the case of Ceylon soils, which are stated to lack calcium, this would be serious, and it would, therefore, not be advisable to use material of the nature of Sample C for agricultural purposes.

The following preliminary tests involving crystallisation, deliquescence, and washing were applied to Sample C to ascertain if a good quality potash salt could be easily obtained from it.

Crystallisation test.—This was carried out by dissolving the crude salt in an excess of water with the addition of sufficient hydrochloric acid to render the solution faintly acid, in order to prevent the separation of magnesium hydroxide on concentration. The solution was evaporated until solid matter separated, allowed to cool, filtered on the pump and the solid sucked as dry as possible. This process was repeated until six fractions were obtained. Their compositions were ascertained and are set out, together with percentage recoveries, in Tables 3 and 4 below.

TABLE III

FRACTIONAL CRYSTALLISATION OF SAMPLE C

Composition of fractions

Fraction.		I	II	III	IV	V	VI
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Magnesium	Mg	0·53	0·34	0·47	6·68	9·44	11·35
Equivalent to magnesium chloride	$MgCl_2$	2·08	1·33	1·84	26·16	36·97	44·44
Sodium	Na	0·37	20·38	23·18	7·26	3·58	0·38
Equivalent to sodium chloride	NaCl	0·94	51·80	58·91	18·45	9·10	0·97
Potassium	K	45·26	20·32	18·65	11·41	2·12	0·22
Equivalent to potassium chloride	KCl	86·30	38·75	35·56	21·76	4·04	0·42

TABLE IV

RECOVERY OF MAGNESIUM, SODIUM, AND POTASSIUM FROM SAMPLE C

Fraction.	I	II	III	IV	V	VI
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Proportion of original material	8·05	7·99	11·92	16·99	4·14	15·47
Proportion of total magnesium	0·57	0·36	0·75	15·16	5·55	23·44
Proportion of total sodium	0·51	27·65	46·91	20·94	2·68	1·00
Proportion of total potassium	38·59	17·20	23·55	20·54	0·99	0·36

The crystallisation of the solution was allowed to continue in each case until a convenient amount of salt had separated, but the selection of the point at which filtration was commenced was quite arbitrary. Little difference was observed in the appearances of the first four fractions, but the first probably contains a little mother liquor and could be further purified by washing with a little cold water or preferably with saturated potassium chloride solution. This fraction could, however, be used for agricultural purposes without purification, as the usual grade of commercial "muriate of potash" contains 80 per cent. potassium chloride.

The second and third fractions are nearly identical, and can be considered together. They contain rather too much sodium chloride for agricultural purposes, although they could be improved by recrystallisation or washing, but the high sodium chloride content would probably make the washing process expensive, and a large proportion of the potash would be lost.

Recrystallisation followed by the washing of the fractions obtained requires careful control and is considerably affected by variations in the composition of the material treated. Salts of a somewhat similar nature to some of these fractions are being successfully treated elsewhere, but on a large scale under expert supervision and with expensive modern plant.

Simpler methods of purification involving deliquescence and washing tests on the original sample were next tried, with the results described below.

Deliquescence test.—Owing to the relative dryness of the atmosphere, a sample of salt C required some days' exposure before absorbing sufficient moisture to form any appreciable amount of liquid. When a fair amount of liquid had formed, the residue was filtered off and dried by suction. On analysis the residue gave the following results:

TABLE V

SAMPLE C. ANALYSIS OF RESIDUE FROM DELIQUESCENCE TEST

		Per cent.
Magnesium	Mg	5·99
Equivalent to magnesium chloride	$MgCl_2$	23·45
Sodium	Na	7·77
Equivalent to sodium chloride	NaCl	19·74
Potassium	K	12·75
Equivalent to potassium chloride	KCl	24·31

Although the percentage of magnesium chloride has been reduced, the concentration of potassium relative to sodium is insignificant, and further tests in this direction were consequently not carried out. Different results might, however, be obtained in a more humid atmosphere.

Washing test.—Sixty per cent. of its weight of water was added to the salt C, the mixture being allowed to stand overnight, and then filtered and sucked dry at the pump. The analysis of the residue, which formed 24·15 per cent. of the original salt, and the recovery of the constituents were as follows:

TABLE VI

SAMPLE C. ANALYSIS OF RESIDUE FROM WASHING TEST

		Per cent.	*Recovery Per cent.*
Magnesium	Mg	1·18	3·81
Equivalent to magnesium chloride	$MgCl_2$	4·62	
Sodium	Na	14·67	60·16
Equivalent to sodium chloride	NaCl	37·29	
Potassium	K	26·68	68·25
Equivalent to potassium chloride	KCl	50·88	

There has been a marked reduction in the magnesium chloride content, although the amount of sodium chloride is still high. Further washing would probably result in increased purification but at the expense of total potassium recovery, over 30 per cent. of the total potassium having already been lost in the first washing.

This washed material could, however, be used as a substitute for imported muriate of potash, although allowance must be made for the fact that all the salts present are chlorides, and not, as in the commercial low-grade potash fertilisers, partly chlorides and partly sulphates.

It may be useful to compare the composition of the original Sample C and of some of the products obtained from it with the composition of some commercial potash fertilisers, the major constituents only being considered.

TABLE VII

	K_2SO_4 *Per cent.*	KCl *Per cent.*	$MgSO_4$ *Per cent.*	$MgCl_2$ *Per cent.*	NaCl *Per cent.*
Crude kainit*	0 to 4	19 to 24	0 to 32	0 to 8	29 to 77
Potash manure salt* (guaranteed minimum 40 per cent. K_2O)	0 to 9	60 to 66	0 to 10	0 to 6	16 to 35
Potash manure salt* (guaranteed minimum 50 per cent. K_2O)	0 to 35	79 to 85	0 to 5	0 to 3	10 to 16
Sample C, as received	Nil	18·00	0·87	28·47	14·97
Sample C, 1st fraction from recrystallisation (Table 3)	—	86·30	—	2·08	0·94
Sample C, residue from deliquescence test (Table 5)	—	24·31	—	23·45	19·74
Sample C, residue from washing test (Table 6)	—	50·88	—	4·62	37·29

* Honcamp: *Handbuch der Pflänzenernährung und Düngerlehre.* Band II, 307.

It will be seen that, allowing for the increased amounts of chlorides, either the first fraction from the recrystallisation or the residue on washing obtained from Sample C could be used as potash fertilisers in place of imported materials.

Conclusions

The results show that crude magnesium sulphate derived from sea-water can readily be purified by simple means.

With regard to low-grade potassium chloride from the same source, owing to the large amount of sodium chloride which is present, the preparation of a pure potassium chloride containing the bulk of the potassium would be difficult without expert attention and would probably be remunerative only on a large scale. Potassium and sodium chloride mixtures, however, suitable for use in agriculture, can be obtained either by recrystallisation or by washing, but the yield is rather low, a considerable proportion of the potassium originally present being lost. Even if standard conditions were very carefully adhered to, the composition of the product would tend to fluctuate somewhat, owing to unavoidable variations in the composition of the original brine.

It is understood that since the receipt of the report from the Imperial Institute on the above investigation, further work in Ceylon has shown the practicability of manufacturing from the residual liquor at the salterns both magnesium and sodium sulphates up to British Pharmacopœia standard. Muriate of potash, containing 80 per cent. KCl, and milk of magnesia, have also been obtained from this liquor.

ARTICLES

THE PRESERVATION OF CITRUS FRUIT JUICES

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The following memorandum has been compiled on the basis of data supplied by the following sources: The Department of Scientific and Industrial Research, The Imperial Institute, The Research Station, Long Ashton, and Dr. L. Lampitt, Chief Chemist of Messrs. J. Lyons and Company. Grateful acknowledgment is made of the assistance afforded in this connection.

In the United Kingdom there is an appreciable trade in the so-called Citrus Squashes and Cordials which, it may be pointed out, are not simply natural fruit juices but juices which have undergone some form of manufacturing or preservative treatment. In the United States of America, and to a lesser extent in certain European countries, there is a considerable trade in fruit juices which are preserved in such a way as to retain unaltered the characteristics of a fresh fruit juice.

In the United States a great impetus has been given to this trade by the medical profession who have advocated the consumption of fresh fruit juice as part of a campaign for health on account of the contents of vitamins. In consequence much attention has been devoted to the preservation of citrus juices by methods which will retain in unaltered form the vitamin contents.

This campaign has as yet not found its parallel in England; it is thought that if similar propaganda was undertaken by the medical profession in this country it would greatly stimulate a trade in fresh citrus fruit juice, and might be the means of extending considerably the consumption of citrus fruit or its equivalent in juice. At present the public has not learned to differentiate between the orange and lemon squashes which are currently sold and fresh fruit juice, and it is believed that the majority of people consume these beverages in the belief that they are actually consuming fresh fruit juice.

The Existing Trade in Citrus Squashes and Cordials in Great Britain

Orange, lemon, grapefruit and lime squashes and cordials are fairly extensively consumed in this country and are manufactured by a number of firms. The basis of these preparations is the juice of the fruit which is imported into this country from the country of origin, usually in chestnut-wood casks which are not infrequently specially lined.

Orange juices are imported from the United States, Spain, South Africa and Jamaica. Lemon juices come from Italy, Sicily and the U.S.A., and lime juices from the Gold Coast and the West Indies.

Imports of lemon and lime juices for the four years 1934 to 1937 are shown below.

IMPORTS OF UNSWEETENED LIME AND LEMON JUICE

	Quantity (Gallons).				Value (£).			
From:	1934.	1935.	1936.	1937.	1934.	1935.	1936.	1937.
Gold Coast	281,588	325,038	411,497	230,718	14,580	17,990	20,697	12,220
British West Indies	74,877	89,895	166,318	124,677	6,648	8,743	15,767	10,676
Other British Countries	10,693	30,496	42,887	3,886	494	3,526	7,420	842
Total from British Countri	367,158	445,429	620,702	359,281	21,722	30,259	43,884	23,738
Germany	—	224	185,854	37	—	106	18,675	69
Italy	813,476	753,121	153,746	583,852	39,503	38,919	9,710	35,079
United States of America	3,214	35,912	131,219	3,460	1,749	5,420	24,126	806
Other Foreign Countries	4,146	18,769	6,376	4,593	286	1,658	1,009	253
Total from Foreign Countr	820,836	808,026	477,195	591,942	41,538	46,103	53,520	36,201
TOTAL	1,187,994	1,253,455	1,097,897	951,223	63,260	76,362	97,404	59,945

Separate figures for the importations of orange juice are not available, but combined figures for importations of unsweetened citrus juices other than lime juice and lemon juice, i.e. orange juice and grapefruit juice, for 1936 and 1937 are shown below.

IMPORTS OF UNSWEETENED CITRUS FRUIT JUICE, OTHER THAN LIME AND LEMON JUICE

From:	Quantity (Gallons). 1936.	Quantity (Gallons). 1937.	Value (£). 1936.	Value (£). 1937.
Cyprus	2,420	8,640	508	821
Palestine	3,330	20,968	299	1,971
Union of South Africa	97,806	195,158	11,016	22,248
Australia	14,607	5,270	1,749	814
Jamaica	20,615	13,893	1,551	871
Other West Indian Colonies	15,343	6,088	1,270	761
Other British Countries	5,371	9,807	—	—
Total British	159,492	259,824	16,393	27,486
Spain	159,402	98,375	12,769	6,973
Italy	1,630	52,204	109	3,886
United States of America	464,643	547,776	59,857	72,766
Brazil	29,924	25	1,734	3
Germany	5,148	6	427	—
Other Foreign Countries	2,981	8,962	2,102	4,821
Total Foreign	663,728	707,348	76,998	88,449
TOTAL	823,220	967,172	93,391	115,935

Lime and lemon juices containing relatively high percentages of citric acid are frequently imported without addition, but orange juice with a lower citric acid and higher sugar content is liable to undergo fermentation during transit and has accordingly to be treated with a preservative; sulphur dioxide is usually employed for the purpose and is added to the juice in the form of potassium metabisulphite. The amount added is in the region of 700 to 800 parts of sulphur dioxide per million. Orange juices imported in this way are usually of a pale yellow colour, thick with pectinous matter and smelling and tasting strongly of sulphur dioxide.

To bring the sulphur dioxide content of orange juices, as imported, within the limits prescribed by the Foods and Drugs Act they require to be diluted to about one-third their original concentration; the diluent employed is usually syrup containing 45 per cent. by weight of sugar; to increase the acidity citric acid may be added, whilst sometimes flavouring is added also. The characteristic deep orange colour of orange squashes is obtained by adding colouring matter—usually carotene is used. In the squashes the pectin remains in the juice.

In the clear cordials the pectin is allowed to settle and the clear supernatant juice is racked off, though sometimes filtration is resorted to.

Preservation of Citrus Juice in a Fresh Condition without the Addition of Preservatives

The preservation of citrus fruit juice in a natural condition is by no means a simple problem. Such juices, and particularly orange juices, are liable to undergo changes on storage which include not only ordinary fermentation, but also oxidation processes which result in loss of flavour and of colour. Moreover it is not possible to treat them by sterilisation or even normal pasteurisation as this results in imparting to them a cooked flavour which is unpleasant and also destroys the vitamins. Changes are also liable to occur in the pectinous material; on long keeping it tends to flocculate and to precipitate in an undesirable manner; while in any case it is essential that in orange juices the pectinous material should be retained as its removal also causes a certain loss of flavour.

Five methods have become evolved for the preservation of fruit juices under conditions which fulfil in a greater or less degree the above requirements. They are as follows:

(*a*) Preservation of fresh fruit juices by simple storage at low temperature.

(*b*) Preservation of fruit juices by "flash pasteurisation," and canning of the product.

(*c*) Concentration of fruit juices by film evaporation under reduced pressure.

(*d*) Concentration of fruit juices by freezing.

(*e*) Treatment of fruit juices by the "Matzka" process.

In the following pages some details are given concerning each of these.

Preservation of Orange Juice by Storage at Low Temperatures

The preservation of orange juice by freezing was first attempted on a commercial scale in Florida in 1931. Early operations were not very successful. Part of the trouble lay in the development of an "off taste" in the frozen juices. Subsequent experience has, however, made it possible to overcome these difficulties and the process is now extensively practised.

The essential features of the process are as follows:

The juice is extracted either from the whole fruit by means of a high speed reamer or by a cup type press or a whirl type press, using peeled fruit. After extraction the juice is run through a strainer and thence to an evacuating apparatus which removes contained air. Thereafter it is transferred direct to the containers and is stored in refrigerated rooms at temperatures which range from 32° to 42° F. It has been found that flavour and appearance are considerably affected by the methods of extraction and it is necessary to avoid the inclusion of too much essential oil and also bitter principles from the skin. The de-aeration treatment is also very important as this affects the keeping qualities of the juice. If de-aeration is omitted juices are liable to darken in colour and go off in flavour as the result of oxidation.

Orange juice treated in this way can be preserved for several weeks in a fresh condition. A very large trade has sprung up in the United States of America in this type of juice during the last few years; it is largely in the hands of cold storage companies and dairies. The juice is commonly stored and delivered in cardboard containers and it is normal in American cities for a carton of orange juice to be delivered at the doors of households with the morning milk.

Preservation of Fruit Juices by Flash Pasteurisation and Canning

The flash pasteurisation method for preserving fruit juices consists essentially in raising the temperature to 185° to 190° F. and maintaining it at that for about ten seconds; treatment in this way gives results comparable to heating to 160° F. for 30 minutes. The advantage of this method as opposed to ordinary pasteurisation is that as the juice is exposed to the high temperature for a very short period the development of the cooked flavour, which is an undesirable concomitant of heat treatment, is avoided.

As in the case of the preservation of fresh juices by cold storage the pasteurisation process must also be accompanied by de-aeration if successful results are to be obtained. It is also usual to combine with them treatment of the juice with a pectin destroying enzyme which enables the opacity of the juice to be controlled without affecting the flavour to the extent that would occur if the pectinous constituents were removed by filtration. Various enzymes of this nature are now marketed by a number of firms under different names. The enzyme is added to the juice after extraction and before de-aeration and pasteurisation, which have the effect of destroying the enzyme, and sufficient interval is allowed to enable the enzyme to perform its functions before the subsequent processes are proceeded with.

In the production of pasteurised citrus juices very careful selection of the fruit is essential and all damaged and partially decayed fruit must be rigorously excluded. The methods of extraction employed are also important, for unsuitable methods of extraction are liable to affect, as with cold stored juice, the flavour unfavourably. A method extensively employed is to halve the fruit mechanically and to hand-spindle the half sections over revolving burrs. Attempts have been made to crush the whole fruit in its natural state, but this method has been discontinued on account of the strong flavour imparted to the extract by the oil contained in the skin. This flavour is regarded as objectionable.

An outline is given below of a method of preparing the juice employed at an American factory which embodies the Stero-Vac process of flash pasteurisation which is claimed to be one of the most efficient for producing this type of product.

The fruit is first grated to remove the oil and then pressed whole, the juice being strained to remove seeds and pulp. The grater consists of two horizontal revolving discs about 4 ft. in diameter, covered with a stainless steel fillet, which rotate at a speed of about 100 r.p.m. and revolve in opposite directions. The fruit is thrown by centrifugal action against the fillet, which punctures the oil cells. The fruit leaves the outside of the first revolving disc and is transferred to the second disc where the grating is continued. At the centre it drops into a continuous press consisting of two discs of stainless steel about three feet in diameter, which revolve in the same direction and come together for a short distance on one side. The whole fruit rolls from the grater into one side of this, is crushed and the juice extracted. After pressing, the crushed peel is lifted off the disc and the juice flows into a stainless steel trough which surrounds the lower disc. It then flows to a finisher which is a mechanical strainer of stainless steel. From the finisher the juice flows to the de-aerating unit which consists of a steam chest with a separating chamber and a condenser, all constructed from stainless steel. Juice flows through the pipes of the steam chest—which are surrounded by hot vapour—under a high vacuum of about 28 inches. Juice flows continuously from the extractors through the finisher and the de-aerating unit and is pumped out by a stainless steel vacuum pump to the can filler, which is so constructed that the juice may be broken to atmospheric pressure in an inert gas such as nitrogen.

For packing grape fruit juice plain tin cans are used, but with orange juice lacquered cans are employed in order to avoid flavour changes. After filling the juice in the cans, it is flash pasteurised by the Stero-Vac process. This process involves heating by steam injection through a patented valve in the end of each can and is performed on a specially designed machine. As the can is removed from the machine the disc in the valve is snapped into place as the result of the change in pressure; it is subsequently sealed by clinching and the cans rapidly cooled. The essential features of the process are quick heating and quick cooling combined with the removal of dissolved air.

Another method of flash pasteurisation has been devised at Long Ashton, where a series of experiments have been carried out on apple juice. In this method flash pasteurisation is accomplished by causing juice to flow as a thin film between two metal sides of a container, which are raised to the temperature of boiling water. The juice is de-aerated subsequently to this and then canned. The Long Ashton authorities have kindly undertaken to carry out tests with this apparatus on samples of citrus fruit juice from Palestine.

Concentration of Fruit Juices in Vacuo

There has been a not inconsiderable development of the concentration of fruit juices in vacuo in recent years. The principle employed is that of film evaporation which has been commercially developed in a variety of industries in the

Kestner type of evaporators. The advantage of the process is that as evaporation takes place from the surface of a thin film it proceeds very rapidly while the high vacuum under which it is performed permits of the employment of a relatively low temperature.

In this way, as in the flash pasteurisation process, it becomes possible to avoid the occurrence in fruit juices concentrated by means of it of the cooked flavour, which is objectionable.

In the process as applied to fruit juices it has been found necessary to make special provision for retaining certain volatile substances which affect the flavour of the finished product and which are removed during the course of evaporation. This is accomplished by the incorporation in the plant of a special device whereby these substances are trapped and condensed, thus permitting of their readdition to the finished product.

A number of plants are engaged on the commercial operation of this process in the United States and a number of brands of concentrated orange juice prepared by the process are on the market. One of the best known is called "Califorange." There is already a small import of this type of product into the United Kingdom, where it is finding increasing favour with manufacturers of orange squashes and cordials.

In operation it is understood that after extraction of the juice some of the pulp may be removed by filtration or by treatment with enzyme in order to obtain a product that is not too viscous and difficult to handle. Such concentrated juices contain about 60 to 70 per cent. total solid matter and it is stated that they can be kept without change at ordinary atmospheric temperature indefinitely. It is understood that the preparation of pure concentrated orange juice by the process is sometimes difficult by reason of the low acidity which affects the keeping properties and that a trade is in consequence springing up in mixtures of concentrated orange and lemon juices, the higher acidity of the lemon juice enhancing the keeping powers of the mixture.

It is understood that one small factory in Palestine has experimented with the concentration of fruit juice in vacuo.

The Concentration of Fruit Juices by the Method of Freezing

Possibly the most interesting of all the various processes for concentrating fruit juice is that of concentration by freezing.

The process depends on the application of the well-known principle that when a solution is cooled below the freezing point of water separation into two phases occurs, a solid phase consisting of pure ice crystals and a liquid phase consisting of the original solution in a more concentrated condition. Theoretically, therefore, it is possible to effect concentration to any desired degree by freezing the solution and then separating out the ice crystals. The process has seen its most important commercial development in Germany under the title of the Krause Process, from the name of its inventor, G. A. Krause, of Munich. There are six or seven examples of the plant at work in Germany and Switzerland. A freezing process has also been developed in France with special reference to the concentration of wines and grape juices. A certain amount of experimental work on the method has been performed by the Department of Scientific and Industrial Research at the Low Temperature Research Station at Cambridge and by the Daniel Sieff Research Institute in Palestine.

It is understood that the process has not so far obtained any commercial application in the United States of America, but the operations of the Krause concern are being watched very closely with a view to possible industrial development.

In its original form the Krause process consisted essentially in freezing the juice in some form of suitable vessel and then transferring the frozen mass to a centrifugal in which the concentrate was separated from the ice crystals by centrifuging. Worked in this way the process has certain obvious disadvantages; in the first place it is discontinuous; a further and more serious objection is that by freezing alone it is only possible to effect concentration up to a total solid content of 55 to 60 per cent. Concentrated to this extent fruit juices are incapable of being preserved unchanged at ordinary atmospheric temperatures and require to be stored under refrigerated conditions if they are not to develop undesirable characteristics, such as darkening in colour, change of flavour, and alterations in the pectinous constituents which cause them to flocculate and precipitate out very rapidly.

Samples of orange juice concentrated in this way and stored at –20° C. for over a year were seen at Cambridge and were found on dilution to have preserved their flavour very well indeed and to correspond exactly with fresh orange juice.

It is obvious that the necessity for storage at low temperatures is a serious drawback, and it has more recently been stated that if higher concentrations of total solids can be obtained this drawback is removed and juices will keep unchanged at air temperatures. It is considered by Krause and others[1] that concentrations of between 60 and 65 per cent. are reasonably safe, but the susceptibility of concentrates to change is a function of the acidity and juices of low acidity require a higher degree of concentration than do juices with high acidity if they are to maintain their condition at air temperatures.

The acidity of citrus fruit juices is, however, in their favour in this respect.

One of the difficulties in the way of securing higher concentrations than 50 per cent. is that at greater concentrations the concentrates become viscous and do not part readily from the ice crystals.[2] One method of getting over this difficulty would appear to be pretreatment of the juices with enzyme to dissolve some of the suspended pectinous material, thereby lowering the viscosity of the finished product.

It is stated that Krause has now perfected a modification of his original process whereby all these difficulties have been surmounted and fruit juices concentrated up to 80 per cent. total solids content, while the process has in addition been made continuous. Through the courtesy of Dr. Lampitt, of Messrs. J. Lyons and Company, samples of raspberry and apple juice concentrates stored at air temperature were seen and it was stated that they had been concentrated up to 80 per cent. total solids content. They appeared to have retained unchanged the aroma and flavour of the original juices. A factory incorporating all the latest innovations is stated to be operating in the Rhineland, but details of the modified Krause process are at present jealously guarded. For what it is worth, I may say that it is believed that the modified Krause process incorporates the principles of pretreatment with a pectin destroying enzyme, preliminary concentration by freezing, followed by final concentration by heat under reduced pressure, but no certainty can attach to this.

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[1] It should be stated, however, that the authorities at Cambridge Low Temperature Station feel some doubts concerning this.

[2] The Cambridge authorities state that they have not experienced much trouble in this respect with orange juice brought up to 57 per cent. concentration.

It is believed by a number of authorities that ultimately the freezing method or a modification thereof will supersede all other methods of concentration of fruit juices.

It is understood that representatives of the Krause concern have been appointed in the majority of countries.

The Matzka Process

The Matzka process is so called after its original inventor, Dr. Wincenty Matzka.

The process seems to depend upon a combination of low temperature flash pasteurisation and metallic silver sterilisation, the liquid being passed in thin layers between two heated metal surfaces. The temperatures attained by the juices are, however, lower than those usually considered necessary for pasteurisation, actually temperatures of from 130-140° F. are employed, and the sterilising action is claimed to depend on the so-called oligodynamic action of the metal with which it is in contact. Moreover, the two metal surfaces are different and electrically insulated from one another so that some electrolytic action is supposed to take place. A certain amount of the metals goes into solution, and the possible effect of this on human health has been questioned.[1]

The process has been tested experimentally by the Ontario Research Foundation and a report on these investigations has been published under the signature of Dr. A. Douglas Barbour, Head of the Biochemistry Department.

In its simplest form the apparatus consists of two concentric tubes, the inner one being of silver and the outer of stainless steel; heat can be applied to the inner surface of the inner tube and the outer surface of the outer tube while the juice under treatment flows through the space between the two tubes. Juice intended for treatment requires to be de-aerated as in ordinary flash pasteurisation, and may be treated with an enzyme or filtered to clarify it. After treatment, the juice is filled direct into bottles with suitable arrangements for sterilising them so as to prevent after-infection.

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[1] In the opinion of the Ministry of Health the presence of small quantities of silver in juices treated by this process might be regarded as a contravention of the Public Health (Preservatives, etc , in Food) Regulations.

Various juices were treated experimentally in the Ontario trials and uniformly satisfactory results were reported. Among the juices treated were orange juice and grapefruit juice, and it is claimed that the products, as well as keeping satisfactorily, compared very favourably with commercial samples of similar juices which had been prepared by the ordinary flash pasteurisation process. Commercial plants are stated to be operating the process at Tiel in Holland, at Tremestieri in Sicily, at Carcagente near Valencia in Spain, at Cheswold, Delaware, in the U.S.A., and at Whitby, Ontario, in Canada.

It is further stated that samples of Matzka processed juice have been examined by officers of the National Research Council of Canada, who were satisfied that it had a superior and more natural flavour than any other processed fruit juice sampled. It is further stated that the concern at Whitby, Ontario, which was inaugurated in November 1937, has had difficulty in keeping up with the demand for its products.

Conclusion

To sum the matter up, the present trade in citrus juices in this country is mainly concerned with the orange, lemon and grapefruit squashes and cordials which are extensively sold. These are, however, far removed from natural fruit juices, and it is believed that if a regular supply of fruit juices preserved by more modern methods became available they would rapidly replace the existing types.

There seems little doubt that the existing demand by the trade in this country is for raw juices rather than for concentrated juices. This is doubtless because the unconcentrated juices at present suit methods of manufacture. If, however, by freezing or other method of concentration the trade could obtain a concentrated juice offering technical or commercial advantage over the present raw juice they would doubtless resort to this material. That there is increasing interest in concentrated juices is shown by the fact that small quantities of juice concentrated by the vacuum process are already coming in.

There also seems reason to believe that interest in fruit juices is being fostered by the milk bars, which are appearing in increasing numbers, at most of which there is a growing sale for fruit juices, especially in the summer.

There also seems little doubt that consumption of citrus juices would receive a considerable impetus if it was as extensively advocated by the medical profession in the United Kingdom as it has been in the United States of America. The great extension of the consumption in the latter country is largely attributed to this factor.

It is not altogether clear which of the processes of preserving citrus juices described offers the greatest prospect of success, i.e. (*a*) extraction of fresh fruit juice, its de-aeration and preservation by cold storage for short periods, (*b*) the preservation of fruit juice by flash pasteurisation and de-aeration followed by subsequent canning, (*c*) concentration of juice in vacuo by a film evaporation process, (*d*) concentration by freezing on the lines of the Krause process, or (*e*) preservation by the Matzka process.

The Krause process of concentration by freezing is thought by some to offer the best prospects in the long run. On the other hand, if the Matzka process fulfils its present promise it also seems to hold out possibilities, but the objection to this process by reason of the presence in the treated juice of small quantities of silver must not be overlooked.

The Department of Scientific and Industrial Research have pointed out that there is no possibility of patenting the actual process of concentration by freezing *per se*. The only points over which patent rights can extend are the details of the apparatus employed.

In conclusion it may be pointed out that while the foregoing information applies in the first instance to the preservation of citrus fruit juices it also has a direct bearing on the preservation of juices of other kinds of fruit. In the Colonial Dependencies interest in this connection at present attaches particularly to the preservation of pineapple juice in Malaya and certain other Dependencies and to passion fruit juice in Kenya ; consequently although the application of the data given lies in the first place in those Dependencies in which citrus fruit is grown, it also has an interest for a number of others.

ADDENDUM

Further Information concerning the Krause Process

Since the foregoing was written further information concerning the Krause process has been made available in a paper by P. Bilham published in *Chemistry and Industry*, Vol. 57, No. 25, pp. 589-593, of June 18, 1938, and from this the following additional notes have been abstracted:

According to Bilham the process in its present form consists in double or treble freezing in a stationary condition, transferring the ice block to a centrifugal, removing the mother liquor by whizzing, and subsequently concentrating the mother liquor by the same means.

The juice is frozen in a special vessel of such a shape and size that the moulded block of frozen material exactly fits the centrifuge employed, the general shape of the juice space is an annular ring which tapers slightly from top to bottom. The vessel is immersed in a brine tank and the brine circulates outside and inside the ring of the container thus ensuring that the temperature gradient is horizontal, which causes the ice crystals to grow along this gradient and so facilitates the separation of the concentrate.

A framework is immersed in the liquid to be concentrated, which provides a means of handling the frozen block and helps to prevent the frozen mass from disintegrating. The remainder of the plant consists of the brine tanks in which the brine is specially circulated for freezing, a second brine tank in which after a certain period of freezing the cell is allowed to " temper " (whereby the temperature of the frozen mass becomes even throughout) and the centrifuge which is provided with a central pipe entering the bowl for the introduction of liquids to wash the ice mass. The whole plant is made of corrosion resistant alloys.

Two brine tanks are provided for freezing and one for tempering, there is one centrifuge, and auxiliary apparatus comprises refrigerating plant and thermostats with storage tanks.

In operation a cell is filled with juice and placed in the first freezing tank for an hour, it is then removed and placed in the tempering tank for an hour, which levels out the temperature throughout the mass. The cell is then plunged into warm water and immediately the content is free it is lifted on its frame, placed in the centrifuge and spun until concentrate ceases to issue from the discharge pipe. The mass is then washed with original juice and then with ice water from previously discarded ice. The washings are used again and again until the solid content has been raised nearly to the level of the first concentrate. They are then added to the bulk.

The process on the second and third concentrations is similar, save that lower temperatures are employed, while the ice from the last concentration is not washed but is added as it is to the original juice.

A cell is filled every twelve minutes and put to freeze; during the interval cells due for centrifuging have to be handled; ice removed from the bowl at the end of washing, transfers made from freezing to tempering tanks, and filling of second and third concentration cells made. The work is stated to be capable of being carried out by four men. The plant has a capacity of 1,250 litres of original juice per hour for continuous night and day work, the latter is essential for successful operation. With wages at 1*s.* 3*d.* per hour, electricity at 1*d.* per unit, and cooling water at 3*d.* per 1,000 gallons the prime cost of concentration is stated to be 1*d.* per gallon of finished product using three stages.

It is stated that the juices produced are excellent in flavour, but to ensure their keeping it is required that the soluble solids-contents be raised to 60-65 per cent. by the addition of sugar. With this they will keep well for six months at a temperature of 5° C. This is not in complete accord with earlier claims reported for juices concentrated by this process. It is also stated that the removal of pectin from concentrated juice by the use of pectin destroying enzymes has been proposed, but it is not clear whether this is as yet actually incorporated in the process.

THE SOUR CREAM METHOD OF MAKING CLARIFIED BUTTER (GHEE)

By M. H. French, M.A., Ph.D.

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The principle underlying all methods of butter clarification is the removal of moisture, protein, and other milk solids so as to facilitate the preservation of the butter-fat. In the older methods, part of the moisture and salts and a large proportion of the proteins were removed during the making of butter prior to clarification. In order to eliminate the work of making butter, a method was developed to make the clarified butter directly from cream and this was described in a previous article in this BULLETIN (1936, **34**, 32). I stated there that the direct boiling of untreated fresh cream was not a success because the large amount of protein curd stuck to the pan and charred. This difficulty was overcome by mixing the fresh cream with water and reseparating to reduce the protein content, and then this washed fresh cream was boiled.

This method of boiling washed cream has been in use in the Government supervised creameries for the past 18 months and very good results have been obtained. One drawback, however, to this method is the frequent shortage of clean water at outlying creameries. It has also happened that cream from a small collecting centre has started to sour before it has reached the central creamery and difficulty has then been found in reseparating the cream and water mixture. In order to reduce the creamery working hours and to overcome these difficulties experiments have been made to bring about the protein separation without it sticking to the pan and burning.

The method now adopted is to allow the fresh cream to ripen until the next day (about 20 hours) and then to boil this sour cream directly without further treatment or washing. The boiling proceeds evenly and the last traces of water boil off smoothly without the spitting usually encountered when boiling washed fresh cream. The protein separates completely and so long as the contents of the boiling pan are stirred gently in the later stages, no charring takes place.

The keeping qualities of clarified butter made from sour cream are quite as good as those of any other type, whilst the product is quite as solid and attractive as the best made in this Territory. Clarified butter made from soured cream can be quite free from any trace of rancidity provided the boiling is done completely and not stopped before the stage described in the earlier article. The acidity compares very well with that of the best quality clarified butter. In the last 20 samples analysed the free fatty acid content of clarified butter made from sour cream ranged from 0·18 to 0·34 per cent. (as oleic acid). These very low values are extremely satisfactory.

NOTES

Ties of Empire.—The following editorial, referring to Sir Harry Lindsay's address printed on pp. 305-316 of this issue, appeared in *The Secretary*, the Journal of the Chartered Institute of Secretaries, for July 1938.

"The Institute Country Conference this year, of which a detailed account appears elsewhere, was linked appropriately with the Empire Exhibition now in progress in Scotland, and provided an opportunity for stimulating interest in the work that is being done to encourage trade within the British Empire by the Imperial Institute at the Empire's centre in London. The Institute Royal Charter extends throughout the King's Dominions, and accordingly the Institute and its members have an especial interest in the imperial aspect of the profession apart from the general interest of strengthening the British tie in the considerable portion of the globe over which the British flag flies. In these times of active international competition under conditions that are in many directions economically unsound and difficult it is more important than ever to foster trading within the British commonwealth of nations, and while trading restrictions imposed by other nations in the name of self-sufficiency or nationalism continue there is an unusually favourable incentive to link up Britain's dominion and colonial empire in a united trading community. It is, of course, true that Britain and each individual Dominion and other component part of the empire cannot reach a measure of normal trading activity without the co-operation of the other trading nations of the world, but a great deal more can be done than has been accomplished at present in closer trade relations among the British peoples. Sir Harry Lindsay was able to show the conference how effectively the Imperial Institute organisation of scientific analysis and report can help in the question of prices and qualities of raw materials which the British Empire possesses in such abundance and variety, whether it be mineral wealth or vegetable products of the soil for manufacturing use or foodstuffs. The overseas empire of Britain is a primary producer, and it is the task of the Imperial Institute to help the importer and manufacturer, as well as the prime producer, by investigation and liaison work, to secure the right quality in good marketable condition at a competitive price. This last consideration is, in some commodities, very difficult to attain under the varying conditions of living and labour costs prevailing in many parts of the world. Even so, cost of production is but a portion of the problem after all, and quality and stability of trading conditions claim an equal share of consideration. In these the British producer overseas can usually claim a pre-eminent place, but he must be able to rely on the trading, goodwill, and active co-operation of his brother at home and in other parts of the empire where his supplies are wanted, and from whence he in turn can obtain the supplies for his own needs. In 1937 the percentage of imports into the United Kingdom from Britain overseas was 39·37, and of exports thereto from the United Kingdom 48·33. Since the date of the Imperial Economic Conference in Ottawa in 1932, when the United Kingdom developed further the policy of preferential tariffs to the Dominions, the value of imports into the United Kingdom from Canada has nearly doubled, and substantial increases in the value of United Kingdom imports can be recorded also in the cases of Australia, New Zealand, and South Africa. The sources of supply and information at the disposal of British traders at the Imperial Institute are exceptionally good, and although they are used extensively at the present time there is no doubt whatever that an even fuller use of those facilities by a wider circle of British traders would result in that more active movement in the direction of inter-empire trade which is long overdue. Present difficulties of international trading are responsible only in part for any sluggishness in empire trade, and a fuller appreciation of our responsibilities and opportunities should bring profit to many in these times of difficulty."

Exhibition Galleries.—Two items which have been introduced during the past quarter into the Exhibition Galleries for the special comfort and convenience of visitors are a Refreshment Room and a series of rest benches. The former is located in the South Gallery near the Central Stand, and here may be obtained light refreshments at popular prices. The rest benches, which follow the design of a garden seat, have been constructed in the Imperial Institute workshops from the following Empire timbers kindly provided by the Colonial Forest Resources Development Department: East African Camphor wood, Trinidad Mora, Gold Coast Danta, British Honduras Pitch Pine and Santa Maria, and Nigerian Opepe; and from British North Borneo Mirabow, White Serayah, and Red Serayah kindly supplied by Messrs. John Ashton, Ltd., Salford.

The benches have been placed in their appropriate Courts, and it is hoped to be able to extend the series as further material becomes available.

The members of the Exhibition Galleries staff have continued to render advice and assistance to exhibitors in connection with the Empire Exhibition at Glasgow, and in return the Imperial Institute has received a number of offers of exhibits for incorporation in the Exhibition Galleries at the close of the Exhibition. A preliminary selection of suitable material has already been made.

A new exhibit in the Indian Court tells the story of the cashew nut industry in Western India. Starting with a view of the cashew tree, this exhibit shows the separation of the nuts, their roasting and shelling, and finally the peeled and graded cashew kernels as exported. The display includes a series of photographs, a model of a fruiting shoot, and samples of the nuts and kernels, and of the oil extracted from the shells during the roasting process.

Another new exhibit illustrates the harvesting and treatment of the chebulic myrobalan (*Terminalia chebula*) for the production of solid myrobalan extract. This display, which has been supplied by the Bhimlitan Tanning Extract Co., Ltd., of Calcutta, comprises a series of photographs, samples of fruits and extract, and a miniature bag of the extract as exported.

A first consignment of exhibits has been received from the Hyderabad States and is displayed in the new Hyderabad Court. The exhibits comprise a variety of silk fabrics, cotton fabrics, woollen carpets, lac-ware, silver filigree work, and bidri ware. The evolution of a finished bidri bowl from the crude cast metal is illustrated by a series of photographs and specimens of bowls at different stages of manufacture.

With the assistance of the High Speed Steel Alloys Mining Co., Ltd., of Tavoy, Burma, and of High Speed Steel Alloys, Ltd., of Widnes, England, an exhibit has been arranged in the new Burma Court under the title "Tungsten for Tools." This exhibit tells by specimens and photographs the story of the winning of the tungsten-yielding mineral, wolframite, its separation and the treatment by which the metal tungsten is obtained. The story goes on to show the application of tungsten, ferro-tungsten, and tungsten carbide in the production of high-speed tools, the production of tungsten electric lamp filaments, tungsten discs for use in the magnetos of motor cars, calcium tungstate for use in X-ray screens and neon lighting, and phospho-tungstic acid employed in colour printing and calico printing dyes.

A Burmese carved teak female figure presented by Mr. Bridgeman has been placed in the Burma Court.

The plumbago exhibit in the Ceylon Court has been rearranged in story form under the heading, "Plumbago a Servant of Vulcan," with the aid of additional specimens received from Graphite Products, Ltd., of Battersea, London. The new specimens comprise coloured paints with a specimen of painted metal, lubricants and pipe joint compound, with a piece of pipe jointing, and asbestos sheeting coated with Ceylon plumbago, from which joint rings are cut.

In the Malaya Court the diorama of a rubber plantation has been brought up to date by the fitting of pneumatic rubber tyres to the latex carts. The diorama has also been repainted.

A series of photographs by Dr. E. Guenther, of Messrs. Fritzche Bros., illustrating the cultivation of the Mawah geranium (*Pelargonium graveolens*), its harvesting and the distillation of the oil in Kenya, has been received through Mr. Hansard, Kenya Essential Oils, Ltd.

A photograph of a tung oil tree has been enlarged from a negative kindly loaned by Mr. T. C. Cairns, Agricultural Officer, Tanganyika.

To the Kenya coffee exhibit has been added a coffee liquoring pot and a coffee set, presented by the Coffee Board of Kenya, to complete the story of coffee from seed to cup.

A collection of mineral specimens, including gold quartz, diatomite, mica, asbestos, rock crystal, corundum, manganese, and galena, has been received from Dr. Harverson, Mining and Geological Department, Kenya, and added to the Kenya mineral collection.

Photographs of tea cultivation, cotton markets, and scenes in Nyasaland have been kindly presented by the Nyasaland Railways, Ltd., also an enlarged photograph of the Lower Zambesi Bridge which forms Nyasaland's outlet to the sea.

A model of the passion fruit vine, showing the flowers and the unripe and ripe fruits, has been supplied through the Passion Fruit Board of Kenya, to form the nucleus of an exhibit illustrating the cultivation of the fruit in Kenya and its use in the manufacture of beverages and preserves in this country.

A set of cotton halos, received from the Director of Economics and Trade, Khartoum, has been added to the Sudan cotton exhibit; also a specimen of fish netting, manufactured by Messrs. W. and J. Know, Ltd., from Egyptian cotton grown in the Sudan.

To the St. Helena Court has been added a sample of St. Helena hemp (*Phormium tenax*) received from the London representative of hemp growing firms in St. Helena.

For the Cyprus Court photographs illustrating the cultivation of cotton and cumin seed have been received from the Director of Agriculture, and a further series of photographs and specimens for story exhibits has been promised.

The reorganisation of the Malta Court on more popular lines was discussed with Sir Harry Luke, Lieut.-Governor of Malta, and Lt.-Col. A. V. Agius, the Trade Commissioner in London, and the first consignment of new exhibits has been received.

For the Canadian Court, a set of photographs illustrating the activities of the firm in the manufacture of pulp and paper has been kindly presented by the Howard Smith Paper Mills, Ltd., of Canada.

PLATE IV

Photo The Times

DAVID LIVINGSTONE

A Statuette in the Northern Rhodesia Court of the Exhibition Galleries of the Imperial Institute

facing page [illegible]]

Under the title " From Chicle to Chewing Gum," an exhibit has been arranged in the British Honduras Court which traces the evolution of a popular sweetmeat. Starting with photographs and specimens illustrating the successive stages in the winning of the latex from the sapodilla tree in a British Honduras forest and its conversion into chicle, it passes to the various operations involved in the preparation of the various forms of chewing gum made in the English factory of a well-known firm.

A valuable addition to the collection of statuettes of Empire Builders in the Galleries is the figure of David Livingstone (1813-1873), which has been placed in the Northern Rhodesian Court (Plate IV). The cost of the statuette has been defrayed by the Northern Rhodesian Government, to whom a replica is being sent. This statuette, like those of Cabot, Van Riebeeck, Raffles, and Brooks, which preceded it in the collection, is a bronze of half-life size, and is also the work of Mr. Herbert H. Cawood. It shows the doctor-missionary and explorer in a simple pose, wearing a suit of sail cloth, Hessian boots, and a cap similar to that worn by British naval officers of his day, with a handkerchief hanging from the back of it and falling over his neck as protection from the heat of the sun. In his right hand he carries a simple staff, rough-hewn from the bush ; in his left hand he holds a Bible ; across his back is a haversack ; and slung over his shoulder is a telescope. The artist copied the features from a portrait sketch he found in the British Museum, and the cap from a reference in a letter Livingstone wrote to his tailor in London, wherein he asked for two blue caps like those worn by British naval officers to be sent out to him. Inset in the black pedestal on which the figure stands is the story of his career from the date of his birth in Lanarkshire to his burial in Westminster Abbey. It recalls his work in a cotton mill as a boy, his graduation at a Glasgow College, his work for the London Missionary Society in Bechuanaland, his crossing of the Kalahari Desert, his travels northwards to the Zambesi and the discovery of the Victoria Falls. Next comes his appointment as H.M. Consul at Quilimane for the Eastern Coast and the independent districts of the interior, his contact with the horrors of the slave trade, and how as a result Nyasaland came to be proclaimed a British Protectorate. Finally comes the account of Livingstone's travels north of Lakes Nyasa and Tanganyika, the discovery of Lake Bangweulu, the historic meeting with H. M. Stanley, his death a year after their parting in the country east of Lake Bangweulu, and the reverence with which his faithful followers carried his body, his papers, and instruments to Zanzibar.

Special Exhibition.—An exhibition of photographs illustrating " African Progress and Activity in Kenya " was held in the Exhibition Pavilion from June 20 to July 2. Mr. Malcolm MacDonald, Secretary of State for the Colonies, presided at the opening ceremony, which was performed by H.R.H. the Duchess of Gloucester. The exhibition owed its origin to Dr. A. R. Paterson, Director of Medical Services in Kenya. It created a good deal of interest and was well attended.

Colonial Visitors.—The following is a list of officers on home leave from the Colonies who have visited the Institute during the three months May to July 1938:

MAY

G. E. BODKIN, Director of Agriculture, Mauritius.
A. B. S. BOSWELL, Senior Assistant Conservator of Forests, Federated Malay States.
H. COOPER, Assistant Colonial Secretary, Gold Coast.
K. A. DAVIES, Senior Assistant Geologist, Uganda.
C. E. DUFF, Assistant Conservator of Forests, Northern Rhodesia.
K. T. HARTLEY, Agricultural Chemist, Nigeria.
W. D. HARVERSON, Mining and Geological Department, Kenya.
Major R. H. C. HIGGINS, M.B.E., Veterinary Officer, Tanganyika Territory.
A. E. MOSS, Agricultural Superintendent, Gold Coast.
E. F. PECK, Chief Veterinary and Agricultural Officer, British Somaliland.
N. S. STEVENSON, Conservator of Forests, British Honduras.
E. J. WADDINGTON, C.M.G., O.B.E., Governor, Barbados.
Sir MARK A. YOUNG, K.C.M.G., Governor, Tanganyika Territory.

JUNE

Professor C. G. BEASLEY, Education Department, Burma.
W. J. CARRIE, Senior Assistant Treasurer, Hong Kong.
Major W. F. CHIPP, D.S.O., M.C., Forest Engineer, Department of Forestry, Malaya.
P. C. DAVEY, A.D.C. and Private Secretary to the Governor of Aden.
Major C. D. V. GEORGI, O.B.E., Senior Chemist, Agricultural Department, Federated Malay States.
C. F. S. JAMESON, M.C., Warden of Mines, Johore, F.M.S.
T. H. MARSHALL, Agricultural Officer, Tanganyika Territory.
I. L. PATTERSON, Inspector of Mines, Federated Malay States.
J. ROBERTSON, Agricultural Officer, Tanganyika.
Professor P. XUEREB, Professor of Physiology, University of Malta.

JULY

H. R. R. BLOOD, C.M.G., Colonial Secretary, Sierra Leone.
R. DAUBNEY, O.B.E., Director, Veterinary Services, Kenya.
Miss M. C. FRANKLIN, Inspector of Schools, Burma Education Service.
C. G. G. GILBERT, M.C., Director of Education, Bermuda.
J. A. GRIFFITHS, Deputy Director of Veterinary Services, Nigeria.
S. P. B. HENDERSON, Inspector of Mines, Tanganyika Territory.
L. F. HIGGENS, Department of Agriculture, Tanganyika Territory.
T. HIRST, Senior Geologist, Gold Coast Geological Survey.
J. A. MAYBIN, C.M.G., Governor, Northern Rhodesia.
J. E. S. MERRICK, C.M.G., O.B.E., Chief Secretary, Uganda.
H. G. MOUNTAIN, Chief Inspector of Mines, Gold Coast.
J. D. POLLETT, Assistant Geologist, Sierra Leone.
C. L. SKIDMORE, Agricultural Superintendent, Gold Coast.
N. D. SPRANGER, Agricultural Officer, Kenya.
G. M. STOCKLEY, Field Geologist, Tanganyika Territory.
C. H. F. WALKER, Agricultural Officer, Nigeria.
E. S. WILLBOURN, Director of Geological Survey, Federated Malay States.

All Dominion and Colonial officers, as well as private residents overseas, who may be visiting London are cordially invited to come to the Institute to see our Exhibition Galleries, and to discuss scientific and technical problems in which they may be interested.

The Preparation of Tung Oil.—Since its inception in 1929 the Imperial Institute Sub-Committee on Tung Oil has been engaged upon the encouragement of the production of tung oil in the British Empire, and among its varied activities it arranged, in collaboration with the Royal Botanic Gardens, Kew, for the distribution of seed for cultivation trials in those countries where climatic conditions appeared to be suitable for the growth of tung trees.

A summary of the results of these and other trials was published in this BULLETIN, 1932, **30**, 24, and a more recent résumé of the experimental work carried out in the cultivation of tung trees in the Empire will be found in *International Review of Agriculture*, 1937, **28**, 281T. As an outcome of these tests it has been proved that tung trees will grow satisfactorily in certain parts of the Empire, while the results of the examination of samples of Empire-grown tung seed received at the Imperial Institute (see this BULLETIN, 1932, **30**, 271; 1933, **31**, 327; 1937, **35**, 147) have shown that it is possible to produce tung oil of excellent quality in the Empire.

As an outcome of the experimental trials mentioned above, a number of private planters and companies have established plantations of tung trees with a view to the production of tung oil on a commercial scale. These plantations are to be found in Assam, Burma, Nyasaland, South and East Africa, Australia and New Zealand, and vary in size up to about 5,000 acres.

In many cases some of the trees are now beginning, or are about to begin, to yield fruit in appreciable quantities, and the Imperial Institute is constantly receiving inquiries from planters and others as to the most suitable means of disposing of their crop and of preparing the oil. In view of this interest the following information is published.

There are two alternatives open to planters desirous of marketing their produce, viz., the sale in the form of nuts or as oil. A decision as to the best course to adopt must be left to the judgment of the grower. To aid him in making a correct decision it may be pointed out that if the oil is to be prepared *in situ* on a plantation a large supply of fruits must be available to render the proposition remunerative and to warrant the initial outlay entailed in the purchase and erection of suitable plant. As an indication of the capacity of the smallest crushing plant recommended as being suitable for the purpose, it may be mentioned that such a model is able to treat in the course of 150 working days the produce from 200,000 trees in bearing. Such a large quantity will be available only on a plantation of considerable acreage or from a group of smaller estates situated in one locality. It may, however, be the case in some districts that other oilseeds are available which might be crushed in the same plant, with or without modification, during part or the whole of the period when it is not being used for tung seed. Preparation of tung oil on a plantation or a group of plantations has the advantages that the freight charges on the oil are naturally less than those on a sufficient weight of nuts to produce the same quantity of oil—a very important factor in some countries—and that the residual oil-cake can be returned in some form or other to the plantation as a fertiliser. On the other hand, oil will require suitable containers, the provision of which may be an expensive item in some parts of the Empire.

In cases where for one reason or another the oil is not prepared on the spot, the fruits will have to be dehusked and the nuts, i.e. the kernels still enclosed in the surrounding thin, brittle shells, after being well air-dried, bagged for transit for crushing in an existing oil-mill either in the country of production or overseas. Where labour is cheap the dehusking of the fruits may be accomplished by hand, with, or without, previous fermentation of the fruits. In China the fruits are allowed to stand in heaps covered with grass, leaves, etc., when the husks are decomposed by fermentation and after about a month the nuts can be separated easily by hand from the mass. Trials using this fermentation method carried out on behalf of the Imperial Institute Sub-Committee on Tung Oil by the Department of Agriculture, Nyasaland, have shown that this method is more suitable for *A. fordii* fruits than for those of *A. montana*, the husks of the latter being more resistant to decomposition than those of the former. If carefully performed so as to prevent the temperature of the mass rising too high, the fermentation method has no adverse effect on the quality of the oil. An alternative method is to dehusk the fruits mechanically using either a hand or power-driven decorticator, the nuts being separated from the broken husks by hand or by a mechanical separator. Particulars were given in this BULLETIN, 1936, **34**, 360, of an arrangement made with Tung Oil Estates, Ltd., Tavistock House (South), Tavistock Square, London, W.C.1, whereby this firm offer to purchase from planters tung nuts of either species in quantities of not less than a ton. This arrangement, although made initially for one year, is still in operation.

In China the first step in the preparation of the oil consists in drying the nuts. For this purpose they are spread out in a thin layer on the ground in the sun and allowed to dry, being stirred at frequent intervals by means of a wooden scraper. In good drying weather the shells begin to break open spontaneously on the second day, and on the third day they are thoroughly flailed to remove the shells. The kernels are then separated from the shells by throwing the mixture a shovelful at a time into a fan-shaped heap. This results in the chaff falling near by, the shells a little further off, while the kernels travel to the periphery of the heap. The separation is completed by hand—picking out any kernels that may still be left among the shells. The kernels are then ground in a circular trench, lined with stone, by means of a heavy stone wheel rolled around the trench and drawn by bullocks. The ground kernels are sifted through a large bamboo sieve of 4 mm. mesh and the coarser particles returned to the trench for further grinding. The sifted meal is steamed for 2 minutes over boiling water and then formed into circular cakes surrounded by straw and iron bands. Thirty of these cakes are introduced into a native press made by hollowing out a large sound log of hard wood or of large squared timbers morticed together. Pressure is exerted by driving a series of wedges into the press. After the kernels have been under full pressure for an hour the cakes are taken out of the press and the adhering straw removed. They are broken up and partially ground in the crushing trench. The coarsely ground material is heated in an iron vessel over a fire to remove moisture absorbed during the early steaming process and then re-ground, sifted, steamed, formed into cakes, and submitted to pressure as before. The total yield of oil obtained as a result of these two pressings is stated to be 50 per cent.

In the case of the treatment of fruits from the recently established plantations in the United States and the British Empire modern machinery is employed. If the oil is to be prepared on a plantation the fruits are either sent direct to the factory unhusked, or if the distance to the factory is considerable the fruits may be roughly dehusked by small portable decorticating machines and the dehusked material transported to the crushing plant, the husks being returned to the soil. In the case of plantations not equipped with oil-crushing plant the product that reaches the factory where the oil is prepared will be in the form of nuts.

At the oil-mill the raw material, whether in the form of fruits or nuts, has to be further decorticated so as to get it in a condition suitable for pressing. The more common type of decorticating machine for tung products consists of two saucer-shaped discs with ridged surfaces, one disc being fixed and the other capable of rotating at high speed. The distance between the two discs can be adjusted to suit the size of the fruits or nuts. The fruits or nuts are introduced into the hopper of the decorticating unit and the husks and shells are broken therein. The broken products and the kernels fall on to a sloping screen of such mesh that as the material travels down it the kernels fall through on to a lower tray and are thus separated from any whole fruits or nuts still in sections of the fruit, while the broken husks and shells are lifted by suction and discharged. The separated kernels are delivered over the end of the lower tray and before leaving it are again aspirated to remove any remaining small pieces of husk or shell. As the presence of a certain proportion of shell in the kernels assists the expression of the oil, the decorticator and separator are so adjusted as to allow the desired percentage of shell to remain with the kernels. About 15 per cent. of shell in the kernels has been found to be a suitable proportion.

After decortication the kernels are ground in a disintegrating mill and are then introduced into the press. Experience has shown that the expeller type of press is the most suitable for tung seed. The ground material on entering the expeller plant, first passes through the tempering trough where it is treated with steam whereby the walls of the oil-containing cells are disrupted and the oil rendered more fluid. Correct tempering of the kernels is an essential for the efficient expression of the oil. The tempered meats are discharged into the expeller proper, where they are crushed, the oil percolating through the interstices of the box and the cake leaving the press at the end opposite to the one at which the meats entered. The oil is allowed to stand in tanks for a few days, during which the bulk of the foots are deposited and the clear supernatant oil can be then drawn off and put into drums. If considered desirable, the oil may be passed through a filter press before being put into containers. The resulting oil-cake, containing 7 per cent. or less of oil according to the efficiency of the crushing, is only suitable for use as a fertiliser, feeding trials carried out on behalf of the Sub-Committee on Tung Oil at the Rowett Research Institute, Aberdeen, having shown it to be unfit for use as a feeding-stuff for animals (see this BULLETIN, 1933, **31**, 352).

The Stamping of Hides and Skins.—An efficient method of marking hides and skins has become increasingly necessary in recent years now that the importance of distinguishing the methods of preparation and denoting the districts of origin has been realised. The need for official marking as a guarantee of shade or suspension drying was pointed out in a previous number of this BULLETIN, 1937, **35**, 74, where the recommendations of the Imperial Institute Consultative Committee on Hides and Skins were recorded.

The requirements of a mark placed on a hide or skin are: (1) it must be reasonably easy to apply at the time of preparation under the conditions of the district in question, (2) the letters forming the mark must be permanent to the extent of being clearly readable when the goods reach the hands of the tanner, and (3) the mark must be of such a size and placed in such a position that the value of the hide or skin is not impaired. In this latter connection the Committee recommended that the space occupied by the numbers or letters of the mark should not be greater than about 1 in. by 2 in., and the marking should be made at the top of the neck or at the end of shank, and should be close to the edge.

Marking by means of ink and stencils or rubber stamps is not so satisfactory as stamping with a perforating die on account of the fatty surface of the skin, the impermanent nature of the mark, and its liability to obliteration.

Dry hides and skins are difficult to perforate owing to their toughness; in the wet condition such a mark can be easily applied, but in general it will be necessary to apply the mark after preparation is completed, i.e. in the dry condition, and therefore in the experiments conducted at the Imperial Institute in conjunction with tanning firms represented on the Committee, dry hides and skins were employed.

Tests were made with hammers containing two different types of dies, one having letters that were a series of points, known as a spike hammer, and the other having letters which were unbroken lines. The dies were "loose fitters," i.e. each letter was a separate die and fitted into a slot in the hammer, the letters being ¾ in. high. Throughout the tests the mark consisted of three letters.

Experiments were also made with branding irons.

The results obtained on cattle hides and sheep and goat skins were discussed in Committee, the conclusions being as follows:

It was agreed that branding gave the most legible mark, but it was anticipated that it might take longer to apply than a hammer mark, and that in some areas provision of fire for heating the iron might be a disadvantage.

The spike hammer was considered to be superior to the line-letter hammer, as the latter was inclined to cut out pieces of the skin, which in falling away leave the letter indistinct.

The Committee approved the use of both branding iron and spike hammer, and recommended that the authorities concerned in the producing countries should make trials with both methods. It was considered that the spike hammer was suitable for skins, but not completely satisfactory for hides, which are tougher in substance; in the latter case a branding iron is more satisfactory and is recommended if facilities are available.

In branding, the hide should be lightly touched with a moderately hot iron in order to mark by slight burning of the hide substance. Excessive pressure and great heat should not be applied, as this may give rise to an indistinct burnt patch or holes.

Slot hammers are available at about 15*s*. each, while the perforating letter dies of the spike type cost about 3*s*. for each die of one letter. A cheaper hammer is obtainable, in which the letters are not loose, removable dies, but are cut on the head of the hammer. Such hammers complete with three letters cost about 13*s*. 6*d*. All the prices mentioned are subject to fluctuation and no doubt lower rates obtain for quantities.

Search for Oil in Australia.—Considerable progress has been made on the petroleum surveys in Australia since the Commonwealth Government passed the Petroleum Oil Search Act in 1936, by the terms of which a sum of £250,000 was voted for oil drilling and surveying expenses in Australia, Papua, and New Guinea, on a basis of a 50 per cent. payment of the cost incurred in approved drilling operations and 33⅓ per cent. of the cost of survey work. In addition the Government has made available the services of a small geological staff, and in 1937 purchased three modern drilling rigs capable of penetrating to a depth of about 8,000 ft. and a portable rig of 4,000 ft. capacity.

At least four companies have to date received financial assistance for drilling operations and allied work in Australia. A group concern under the name Oil Search, Ltd., has been drilling at two sites in Queensland and two in New South Wales. In the former State the rigs are located at Hutton Creek and to the north at Arcadia (25°, 149°), and the first-named boring had gone down by means of cable tools to 3,715 ft., when the limiting capacity of the plant was reached, the bit then being in Permian beds. On application to the Government the Company was loaned a 7 in. rotary outfit, and at the end of 1937 the hole was being reamed to take 10 in. casing. The Arcadia bore has reached a depth of more than 4,000 ft., also by cable tools, and below 1,315 ft. several wet-gas showings were encountered, amounting in certain cases to over 2 million cu. ft. of gas per day at 350 lb. pressure. The gas is unusual in that it contains a large percentage of carbon dioxide. The use of a Government drilling rig is also being requested for this bore since the capabilities of the plant so far employed are exhausted.

In New South Wales drilling proceeded to a depth of over 6,000 ft. at Kulnura, 45 miles north of Sydney, and is now temporarily suspended; west of the city, at Mulgoa, a bore has been put down to 3,125 ft. by a light plant. The Company has not, as yet, reached a decision as to whether it would be advantageous to deepen these bores or commence new ones.

For many years there have been reasonable expectations of finding oil in the Roma and Longreach districts, in both of which strong indications of gas and oil are present. In 1927 a concern known as the Roma Oil Corporation, Ltd., put down two bores reaching 3,706 ft. and about 4,000 ft. respectively, which passed through oil and gas horizons, and numerous other companies also began drilling, but the scarcity of outcrops made the interpretation of the local geological structures difficult, and therefore the selection of suitable drilling sites fortuitous. Operations ceased in the years of depression, but are now recommencing, and another undertaking, the Roma Blocks Oil Co., has reopened a bore made in 1931 near Roma which is yielding daily a small quantity of good quality oil associated with a large amount of water. Careful and detailed geological surveying has revealed that the well is actually situated in a syncline and that an anticlinal structure exists near by which offers very favourable prospects.

Oil has also been obtained in Victoria from a well drilled near the seaside town of Lakes Entrance about 200 miles east of Melbourne. The well was put down by the South Australian Oil Wells Co., and in 1930 struck 38 ft. of oil-bearing glauconitic sands below 1,245 ft., from which a flow of about 10 gal. a day was obtained. The oil well is now controlled by the Austral Oil Drilling Syndicate and for some years has been giving as much as 200 gal. daily. The oil is about 20° Bé with a strong smell, and contains a small quantity of gasoline, 24 per cent. kerosene, 57 per cent. light and heavy lubricating oil, and 16 per cent. bitumen. An unsuccessful attempt was made with Government aid to augment the output by reopening another old well, but only a few gallons of oil and emulsion were obtained each day. New test wells are being considered.

A fourth concern, the Lake Wellington Oil Co., is being assisted by the Government to deepen its boring near Sale, 50 miles south-west of Lakes Entrance, which has, according to the latest information, reached 2,200 ft., and is traversing a series of Oligocene sands and lignitic beds, but has not encountered the glauconitic sand of Lakes Entrance.

The search for oil in Papua and New Guinea dates back to pre-war years, when in 1911 indications of petroleum were reported from the Vailala River, and after several trials, Commonwealth Government geologists did strike a small quantity of oil in a shallow bore. Extensive surveys were then made between Yule Island and the Purari Delta and oil was encountered in several trial bores. After the war the Anglo-Persian Oil Co. put down several bores which, however, did not reveal the presence of oil in commercial quantities.

Shallow borings made in New Guinea at Matapau revealed the presence of oil on the north coast of the Island.

Oil Search, Ltd., is now carrying out geological work in Papua and New Guinea, and good structures have been encountered in Tertiary sediments, of which great thicknesses are oil-impregnated. The extreme inaccessibility of the terrain has been overcome by aerial approach.

In addition, the territory in the vicinity of the Fly River and in north-eastern New Guinea is being surveyed by a Standard-Vacuum subsidiary. The Islands Exploration Co. and the Papuan Oil Development Co. (Royal Dutch-Shell) are carrying out geological and geophysical work in western Papua.

A purely Australian undertaking, the Papuan Apinaipi Co., is doing reconnaissance work on a series of folds at Jokea, 75 miles north-west of Port Moresby.

The Deepest Oil Well yet Drilled.—The search for oil goes on at ever-increasing depths, and an account has been published (*Min. Metall.* 1938, **19**, 315) of the task recently accomplished by the Continental Oil Co. in drilling a well at a site about 4 miles west of Wasco in the San Joaquin Valley, California, down to a depth of 15,004 ft., which represents a 2,200 ft. advance on the previous deepest bore situated in western Texas. The well has proved to be a productive one and oil of 36° Bé is flowing at a rate of 3,600 barrels daily from a middle Miocene sand at a depth between 13,092 and 13,175 ft.

The well was drilled to its final depth in 284 days and completed as an active producer in 296 days. A survey of the hole was made at 11,570 ft. at which point the deviation from the vertical only amounted to 21 ft., and after side-tracking the bit from 11,584 ft. the maximum deviation thereafter never exceeded 2½°.

The temperature readings ranged from 196° F. at 6,000 ft. to 268° F. at 15,000 ft., giving a gradient of 1° F. for every 125 ft., and the similarity of temperatures at related horizons in other wells at shallower depths appears to indicate that the factor controlling temperature at any sub-surface point is more likely to be its distance from the basement rocks than from the surface.

The Ironsands of New Zealand.—A general description of the large deposits of ironsand on the coast at Taranaki, North Island, and an account of the various attempts that have been made to utilise them has been given by A. W. Wylie in a paper which was abstracted in this BULLETIN, 1938, **36**, 75-78.

In a more recent paper entitled "New Zealand Ironsand in Relation to Overseas Deposits of Titaniferous Magnetite" (*N.Z. J. Sci. Tech.*, 1938, **19**, 572-584), the same author reviews the chemical composition of other titaniferous vanadiferous iron-ores, the world production and utilisation of titanium and vanadium from such ores, and the methods employed. His summary of the methods which have been employed is enhanced by a valuable bibliography. The Taranaki ironsand, he concludes, cannot be regarded as a profitable source of titanium compounds alone, for the titanium content is small compared with that of other well-known deposits. The great quantity available and their freedom from sulphur and other impurities render these ores desirable for certain steel-manufacturing practices, while the corresponding slags will, he believes, eventually provide a new source of both vanadium and titanium.

As was pointed out by Wylie, one ton of the ironsand contains 2 cwt. of titania and 4½ lb. of vanadium. It is therefore of interest to find that A. D. Munro and H. S. Gibbs (*N.Z. J. Sci. Tech.*, 1938, **19**, 523-526) have made a preliminary study of the problems involved in devising a process to recover these constituents while leaving the ore in a more suitable form for iron production.

Treatment with hydrochloric acid was soon abandoned, and experiments were then made with fusion mixtures selected with a view to low cost. The results of a large number of these experiments are tabulated, the most promising indications being given by mixtures of calcium oxide (CaO) and calcium chloride ($CaCl_2$). Fusions with these mixtures were then studied in greater detail and it was found that six parts of a mixture containing 40 to 50 per cent. of calcium chloride and 60 to 50 per cent. of lime to one part of ironsand extracted approximately 90 per cent. of the vanadium and titanium when the fusion product was leached with weak hydrochloric acid, the iron being left as Fe_3O_4. Extraction with water proved ineffective in separating the vanadium and titanium from the iron; presumably they are present as calcium vanadates and titanates of low solubility. Extraction with dilute acid increases the cost of the process, but is reasonably effective, and as hydrochloric acid forms calcium chloride the process is rendered cyclic for this substance. Unfortunately, some vanadium and titanium are left with the iron, but in dilute acid solution very little iron is dissolved. On adding calcium hydroxide to this solution to pH5 a precipitate forms containing all the dissolved vanadium and three-fourths of the titanium. On boiling the filtrate the remaining titanium and iron separate.

According to this scheme, the ironsand is freed from a great part of the titanium and vanadium originally associated with it, and may prove easier to work than in its original state. Two concentrates are produced, neither free from iron. The first contains 90 per cent. of the original vanadium, together with most of the titanium ; the second, titanium but no vanadium. Both should be of value.

The authors point out that the present work is a suggestion towards utilisation rather than a working plan, and further experimental work is to be carried out.

Metallic Calcium and Its Uses.—Supplies of highly pure calcium metal are now on the market and the metal is beginning to find new applications, especially as an alloying element. P. Bastien has reviewed modern methods of production and has summarised its properties and uses in a paper presented before the Société de Chemie Industrielle, a translation of which was reproduced in the *Metal Industry*, July 1, 1938, pp. 3-4.

Only the electrolytic methods of manufacture have succeeded on an industrial scale, and in these the fused anhydrous chloride is the salt almost exclusively used. Metal so produced contains a small but important percentage of calcium chloride, which is removed by remelting in a closed vessel, the molten calcium being cast into ingots. When of good manufacture this metal contains from 98·4 to 98·6 per cent. calcium, the impurities being silicon, phosphorus, iron, aluminium, the alkali metals, and some salts (calcium hydroxide, chloride, and nitrate). Very pure metal with about 99·5 per cent. of calcium can be obtained by sublimation *in vacuo* and by remelting in an atmosphere of argon, a refining process actually in commercial use in France.

Experiments with the sublimated calcium have given a more accurate and reliable knowledge of the properties of the metal than was formerly possible, while the commercial manufacture of refined calcium has permitted the study of its mechanical properties and the discovery of the fact that it is capable of deformation in almost the same way as lead.

The applications of metallic calcium are numerous, but from the metallurgical point of view, because of its lack of corrosion-resistance, it has not so far found any application as a base metal in industrial alloys. It has, however, found many uses as a deoxidising or refining agent, or as an addition agent, especially in various lead-base alloys.

It is particularly useful as a deoxidiser for copper, the resulting metal having a very high electrical conductivity, and has also been employed as a deoxidiser and desulphuriser in the metallurgy of nickel and its alloys. As a result of its affinity for oxygen, sulphur, and arsenic, attempts have been made to use the metal and certain of its alloys in the metallurgy of iron.

It has been shown that calcium, with or without the simultaneous action of oxidising agents, when added to certain silicon alloys, has the effect of making the castings stronger and of finer grain size. Use has been made of this process industrially, and it is of special value when used with phosphorus-bearing melts, giving better mechanical properties.

Added to lead as a hardening element, it gives an alloy which has certain advantages over antimonial lead, particularly from the point of view of stability of mechanical properties over long periods. This property and also the resistance to fatigue of lead-calcium alloys have assured for them a promising market in the cable-sheathing field as well as for the manufacture of grilles and plates for accumulators. The lead-calcium alloys are also used as antifriction alloys such as the " Bahnmetall " of the German railways.

Calcium metal is also used for eliminating bismuth from lead, for lessening the possibility of liquation in the manufacture of leaded bronzes, and for reducing the tendency of molten magnesium to burn when in contact with air.

Extraction and Uses of Indium.—The existence of small quantities of the rare elements, indium, gallium, and germanium, in some of the complex zinc sulphide ores has been recognised for some time, but the extraction of these elements was a tedious and expensive process and the demand for them was very limited. With the introduction of various wet methods of extracting zinc, the concentration of rare elements in the complex residues obtained has become of considerable interest, and if sufficient uses could be found for these metals they could be produced commercially with comparative ease.

Indium has been the subject of much recent work, both from the point of view of extraction and of uses, and an article by R. E. Lawrence and L. R. Westbrook (*Industr. Engng. Chem., Industr. Ed.*, 1938, **30**, 611), describes a method of extraction from a wet zinc-process residue and indicates possible uses of the metal. In this process indium is concentrated in the waste mud, which is collected and extracted with hot dilute sulphuric acid giving a solution containing indium and other metals. This solution is treated with metallic zinc which causes indium to be precipitated as a sponge, containing also cadmium and a little lead, nickel, tin, and copper. The sponge is filtered off and is first leached with a carefully controlled amount of hot dilute sulphuric acid, sufficient to dissolve out most of the cadmium. The remaining sponge is afterwards dissolved in a further quantity of acid, and the solution filtered from lead sulphate and other insoluble matter. An excess of ammonia is then added and indium is precipitated as the hydroxide which is digested until it becomes granular and is then filtered off, washed, dried, and ignited to trioxide.

This still contains impurities, but metallic indium of 97 to 98·5 per cent. purity can be obtained from it by an electrolytic method. If required, a further purification process can be applied, resulting in a very pure product.

In spite of much research into possible applications of indium, it is doubtful if any of the uses suggested have yet been adopted on a commercial scale. The most promising outlet seems to be as a constituent of precious metal alloys for jewellery and dental work, in which indium increases the resistance to corrosion. Silver-indium alloys containing from 1 to 25 per cent. of indium have been developed for plating silverware to prevent tarnishing. A dental amalgam base containing 95 per cent. mercury and 5 per cent. indium, which, it is claimed, improves the mechanical properties of the finished filling, has been patented.

When indium is added to some low-melting alloys such as Wood's and Lipowitz' alloys, the melting point is still further reduced. Thus Wood's metal to which 18 per cent. of indium has been added gives an alloy with a melting point of 46·5° C.

A patent covering the use of indium as a constituent of bearing metals was taken out some years ago, and it is believed that further work on these lines is in progress. Glass containing indium oxide and sulphur compounds possesses a light yellow to dark yellow-amber colour and one part indium oxide in 2,000 parts is said to give a beautiful yellow glass. Other possibilities are being actively investigated, and if an important application can be discovered there is no lack of raw material from which the resulting demand could be satisfied.

Lithium Compounds and their Uses.—During the last few years the importance and technical uses of lithium and its salts have greatly increased, lithium compounds being largely used to-day in ceramics for the production of more satisfactory glazes, in the enamelling industry, and in glass technology. They have also played a large part in the development of arc welding and air conditioning.

An article entitled "Lithium in Glass and Ceramics," by Dr. E. Preston, of Sheffield University, in the July issue of *Foote-Prints*, outlines the technology of lithium and its compounds.

Only three of the numerous lithium-bearing minerals, namely amblygonite, spodumene and lepidolite, can be worked economically. Of these, amblygonite has the highest lithia content, commercial samples averaging 8·21 per cent. lithia. Although largely employed for the manufacture of lithium chemicals, it finds application also as a fluxing agent in ceramics, in opal glazes, and in certain types of enamels. Spodumene, however, is the lithium mineral most frequently used in commerce ; commercial samples are said to vary between 4·5 and 7·5 per cent. lithia. When spodumene is incorporated in a whiteware body an expansion frequently occurs on firing ; this expansion can be controlled, and the suggestion is made that this fact might prove extremely useful in overcoming the production difficulties with certain whiteware bodies and is worthy of further investigation. Lepidolite is the lithium mineral that exerts the most powerful fluxing effect, on account of its high content of potash and fluorine in addition to lithia, and for this reason it is largely used in glass melting, especially in the manufacture of opal and heat-resisting glasses.

The impurities present and the variation in composition of natural lithium minerals has led to the use of chemically prepared lithium salts in ceramic work. The salts of commerce are the carbonate, fluoride, nitrate, and chloride, but by far the most important is the carbonate. Relatively recent is the development in the use of the chloride and bromide as air desiccants. This application involves regenerative principles, a comparatively small quantity of either halide or both, together with similar hygroscopic halides such as calcium chloride, in the form of a highly concentrated solution, is capable of dehydrating a very large volume of air. Possible applications of this principle lie in the rapid drying of many commercial products such as gelatine, leather, and photographic film.

The use of lithium carbonate in the production of better quality glazes is wide. Additions of 1 per cent. or so to dinner ware and sanitary ware glazes have been found beneficial in increasing the gloss, while in electrical porcelain it is of value in producing a glaze of high strength and resistance to weathering. Owing to its strong fluxing properties, the use of 9 to 12 per cent. permits the amounts of alumina, lime, and silica which may be used in a raw alkaline glaze to be increased considerably, with the result that a more stable glaze is produced. Such glazes may still be sufficiently alkaline to produce the beautiful and vivid copper blues and other typical alkaline glaze colours. In many leadless glazes lithium carbonate may also be used with advantage. In those ceramic formulæ where fluorine is a constituent, lithium fluoride may be employed in place of the carbonate.

Advantage is taken in glass technology of the peculiar properties of lithium in a manner analogous to its uses in ceramics. One example is the use of lithium and barium oxide to replace red lead in the manufacture of a soft glass, the hardening effect of the barium oxide being counteracted by the increased softening due to the use of lithium oxide. The successful use of lithia in glass-making lies in the fact that much smaller amounts are required to produce a glass of the necessary fluidity for working, with the desired physical and chemical properties, than is the case with soda or potash. Lepidolite is frequently used when it is desired to introduce lithia, alumina, and fluorine into the glass. Glasses of high lithia content also possess greater transmission of ultra-violet light than those containing soda or potash.

An interesting use of lithium products in glass manufacture is the etching effect produced by the attack of molten lithium nitrate on glass.

Activated Magnesia.—The method of preparation of a new magnesium oxide product claimed to possess certain properties which make it suitable for use as a decolorising, neutralising, or absorbing agent in industrial processes is described in the *Chemical Trade Journal,* 1938, **102,** 440. The activated magnesia is made by heating precipitated magnesium hydroxide until 80 to 85 per cent. has been converted into oxide. A magnesium hydroxide slurry is first obtained by the precipitation of magnesium hydroxide from brine. This is brought about by the addition of milk of lime. Under the proper conditions a highly hydrated form of the hydroxide is formed which settles readily and can be removed from the mother liquor by filtration. After washing, the hydroxide paste is dried to a powder and converted into activated magnesia in rotary kilns at a suitable temperature. In practice a temperature of about 750° F. has proved satisfactory, the calcination being completed in less than ten minutes.

The activated magnesia is a dry powder which, on the average, contains 70·84 per cent. magnesium oxide, 14·38 per cent. magnesium hydroxide, 8·78 per cent. magnesium carbonate, 1·36 per cent. magnesium sulphate, 3·42 per cent. calcium carbonate, the remainder being silica, sodium chloride, and oxides of iron and aluminium. The powder is stated to possess an absorptive power for colouring matter five to ten times greater than bentonite or fuller's earth. It has also been found to operate with increased activity as a neutralising agent in chemical processes.

Investigations have shown that the activity of the magnesia has a definite peak depending chiefly on the temperature of calcination and the proper distribution of the heat.

Discovery of Strontianite in Newfoundland.—The occurrence in Newfoundland of strontianite associated with barytes has recently been reported by A. O. Hayes and H. Johnson in a special bulletin referred to by A. K. Snelgrove in *Information Circular* No. 4, 1938, p. 126, issued by the Newfoundland Geological Survey. The deposit occurs in a limestone of the

Codroy series of Lower Carboniferous age, about ½ mile inland from Boswarlas, on the west coast.

Seven pits sunk some years ago give indications of having reached the deposit, but they are now partly filled with debris and groundwater. The pits explore a distance of 60 ft. in an east-west direction and 100 ft. north-south. The total thickness and extent of the deposit cannot be ascertained owing to the condition of the pits, but Hayes and Johnson sampled a thickness of 15 in. with the following results: Sr, 41·16 per cent.; Ba, 1·84 per cent.; SO_3, 49·17 per cent.; CO_2, 0·71 per cent. In other analyses up to 55·7 per cent. of barium was found.

Full details concerning the uses of strontianite, together with other relevant information of an economic nature, will be found in a new monograph on Strontium minerals published by the Imperial Institute in 1937, price 1*s.* 6*d.* net.

Concentration of Zircon by Flotation.—Although zircon is an abundant constituent of many beach sands, notably in India, Australia, and the United States, the difficulty of separating it from its associated minerals presents a formidable problem. Zircon is a non-magnetic mineral of high specific gravity and therefore a preliminary concentration can be effected by gravitational and magnetic methods. In this way it is comparatively easy to free the mineral from its common associates, quartz, felspar, magnetite, ilmenite, and monazite, but the resulting concentrate almost invariably contains rutile, another non-magnetic mineral of high specific gravity.

As a means of further concentration the efforts of investigators have been turned towards flotation, and some of the methods employed and the results obtained are discussed in a recent paper entitled "Flotation and Agglomeration Concentration of Non-metallic Minerals" (*Rep. Invest. U.S. Bur. Min. No.* 3397, May, 1938, pp. 19-20).

The recovery of zircon from the Australian beach deposits has been a subject of investigation during the past few years. These sands, of which magnetite is the chief constituent, contain zircon, rutile, ilmenite, monazite, garnet, kyanite, quartz, and felspar in varying amounts. The preliminary concentration consists in the removal of the lighter minerals by gravitational methods and of the highly magnetic minerals by low-intensity magnetic separation. The residue then contains zircon, rutile, and monazite, all minerals of high specific gravity, so that gravity separation methods are no longer effective. For their concentration a number of flotation methods have been devised and patented.

The majority of these methods make use of phenomenon known variously as "selective filming," "selective greasing," "collection," or "activation," the principle of which, in brief, is that certain reagents exercise a preferential affinity for certain minerals. It was found that, in general, a substance which gave satisfactory results as a "collector" for froth flotation was also a satisfactory reagent for agglomerate tabling. It may be noted here in passing that the essential difference between the two methods of concentration is that in flotation a frothing agent must be added to promote separation whereas in agglomerate tabling flocculation of the particles is brought about by the addition of a heavy oil.

In one flotation method for the concentration of zircon the reagent employed was oleic or some other unsaturated acid, together with soap and a frothing agent. In cases where the particles could not be floated agglomerate tabling using the same reagents was successful. In a similar flotation process patented by the same investigator a reagent consisting of an alkali salt of the sulphate of an unsaturated alcohol, such as sodium oleyl sulphate, was employed.

In the case of a zircon-rutile-ilmenite mixture selective filming was brought about by the addition, in carefully restricted quantities, of a soap solution, after which the zircon was floated off in water. The rutile and ilmenite were recovered by continuing the process.

A very similar type of treatment was employed with a zircon-rutile-monazite mixture. The sand was first washed with an acid solution, then with a dilute soap solution or a fatty acid emulsion, and finally with water. Washing with water removes any excess of reagents and so prevents non-selective bulk flotation. In some cases it was found more satisfactory to substitute an acid solution for water in the final washing.

The results obtained by this flotation method are interesting. When the preliminary acid wash was carried out with a solution of HCl of less than 10 per cent. concentration, zircon and monazite were floated together while rutile remained in the tailing. On the other hand, an increase in the acid concentration to from 10 to 20 per cent. was observed to bring about the flotation of the zircon alone. Furthermore, when the zircon-monazite concentrate obtained as a result of dilute acid treatment was washed with stronger acid and refloated, a zircon concentrate and monazite tailing were obtained.

The report does not indicate that any of these methods have been successfully applied on a commercial scale.

Asbestos for Sewage Treatment.—A new process for the treatment of sewage known as the Z-process is described in the July issue of *Asbestos*.

The process is said to have been demonstrated over considerably more than a year at an experimental plant handling the sewage of the village of St. Gall, Switzerland, where there are 300 inhabitants. The asbestos is used to promote both clarification and purification, the process being briefly as follows. The sewage is delivered side by side with a quantity of asbestos fibre and some waste-water sludge into a large tank and the mixture agitated by rising streams of compressed air. The oxygen in this air acts upon the micro-organisms and brings about biological changes that cause most of the suspended living matter to settle. In this way about 75 per cent. of the suspended solid matter is said to be removed. The mixture from this tank is then carried over into a decanting tank where the asbestos, laden with adhering organic matter, is deposited, the purified water passing on through first a bed of clinkers and then a bed of sand in order to remove any remaining asbestos fibres. The residual sludge from the decanting tank is pumped back into the first tank where it promotes the essential bacterial activity.

It is claimed that only 2 or 3 gm. of asbestos are required per cubic metre of water to be cleaned and that the action is very rapid. It is also claimed that this process can be used when temperatures below 42° F. would arrest the activities of micro-organisms and make other systems of clarification and purification virtually inoperable.

Calcium Metaphosphate Production in Tennessee.—After some years of experimenting the Tennessee Valley Authority, U.S.A., has succeeded in perfecting a plant for the production of metaphosphate from rock phosphate and phosphorus, an account of which has appeared recently (*Chem. Metall. Engng.*, 1938, **45**, 318-322). The plant is located at Wilson Dam in the Tennessee valley and has a rated output of 2 tons of fertiliser per hour.

The metaphosphate unit is operated on crude phosphorus which is a sludge containing considerable proportions of solid impurities and water. This is stored underground in concrete tanks lined with acid-proof bricks and is circulated by submerged centrifugal pumps through a steam-coil heated pipe-loop, from which a metering pump draws off the requisite amount of feed for a combustion chamber and furnace.

The phosphorus is dispersed in a fine spray into the horizontal combustion chamber by means of compressed air jets, and the initial stages of combustion commence generating a sufficiently high temperature to volatilise the bulk of the phosphorus and water. The products then pass into a vertical furnace, complete combustion being attained by a tangential air-blast across the gas stream from the inlet port.

The P_2O_5 vapours pass out at the top of the furnace into an absorption tower packed with sized phosphate rock ($\frac{3}{8}$-3″). Severely corrosive conditions exist at the throat of the tower immediately over the furnace and to date the material offering greatest resistance has been found to be zircon refractory blocks.

The calcium metaphosphate formed by the absorption of P_2O_5 by the rock phosphate is a viscous liquid which drains into a well at the base of the furnace and is withdrawn periodically in the form of a molten glass-like substance into a rotary drum cooled externally by water. As cooling proceeds, the material forms a layer on the drum walls which progressively cracks, flakes off, and is discharged to a crushing and screening plant.

Plant-operations are commenced by burning oil in the combustion chamber to raise its temperature to the requisite heat, when a change-over to phosphorus is made, and temperature control is maintained by varying the rate of feed of phosphorus and air. Normal temperatures in the combustion chamber range between 1,800° and 2,200° F. and in the furnace a temperature between 1,900° and 1,920° F. Under these conditions a depth of 6 ft. of phosphate rock in the absorption tower has been found to give a 98 per cent. recovery of the P_2O_5, with a possibility of recovering about 75 lb. per hour of fluorine from the waste gases.

The fertilising value of calcium metaphosphate has been definitely established.

Rarer Elements in Ceramic Pigments.—Ceramic pigments may be defined as inorganic compounds, mixed crystals, colloidal suspensions, or inert oxides stable at high temperatures, fast to light and, in many cases, resistant to attack by acids and alkalis. The range of substances which fulfil all these conditions is, of necessity, very limited, but research, particularly in the field of the lesser-known elements, has gradually increased their number and variety.

In the issue of *Industrial and Engineering Chemistry* (*Industrial Edition*) for July, 1938, **30**, 770-772, C. J. Harbert discusses the results obtained with ten of the less familiar elements. These fall primarily into two groups, one containing the elements titanium, zirconium, tin, cerium and molybdenum, which form white oxides, and the other containing the elements vanadium, selenium, neodymium, praseodymium and uranium, which form colouring oxides.

The use of *titanium* pigments in the ceramic industry has increased appreciably in recent years since the development of processes for the production of high-grade titanium oxide on a commercial scale. As a paint pigment, the oxide is well known for its opacifying properties, but it fails, on account of its solubility, as an opacifier in enamels. Combined with antimony, however, titanium oxide increases the acid resistance of enamels, and zinc antimony titanate, consisting of a solid solution of zinc antimonate and zinc titanate, is finding increasing favour as an enamel opacifier. Colours ranging from ivory to dark tan can be obtained by using calcined and rapidly quenched rutile, and a light yellow ceramic pigment is made by calcining a mixture of equal parts of rutile and zinc oxide. The most important titanium pigment, however, is stated to be a new compound consisting of chromium, antimony, and titania. This solid solution is a strong, inert pigment, 2 or 3 per cent. of which will produce, in pottery bodies and glazes, a fast yellow colour able to withstand temperatures up to 1,300° C.

The consumption of *zirconium* in the ceramic industry as zirconium silicate and oxide has also increased in recent years. As an opacifier, zirconia of the proper crystal form and combined with zinc oxide has been used with great success. Coloured pigments containing zirconia are as yet unimportant on account of the fact that the oxide does not possess the necessary chemical activity for the development of ceramic colours.

Compared with its many other applications, the amount of *tin* used in the ceramic industry is small. Tin oxide made by the French process is a fine white powder of tetragonal crystal form which has been used for many years as an eminently satisfactory opacifier. More recently there have been developed a number of ceramic colours with tin oxide as the main constituent. A sky-blue colour, known as Cerulean Blue, is obtained from a mixture of tin oxide with magnesium and cobalt oxides. This cobalt magnesium stannate is permanent to light and strongly resistant to acids and alkalis. A compound containing about 1 per cent. of chromic oxide, 3 per cent. of silica, and the remainder calcium stannate is known as chrome-tin pink and is a very stable rose-red to bluish red glaze stain. The red colour can be intensified by increasing the calcium content of the pigment.

Cerium opacifiers are little used, chiefly on account of the difficulty of preparation. Good ceric oxide, however, comes very high up in the list of opacifiers and the development of a satisfactory concentration process will doubtless greatly increase its use. In the field of colouring pigments cerium titanate can be used to produce a gold-yellow colour in glass. Other cerium pigments, used particularly in porcelain decoration, are blue ceric molybdate and a bluish green ceric tungstate.

Of *molybdenum* salts only lead molybdate is important in ceramics. It is used as an opacifier in low-fired glass enamels. Firing at higher temperatures produces a yellow colour which can be used as a glass stain. Lead phospho-molybdate is reputed to be a good opacifier and a few relatively unimportant blue and green glass stains are known.

Turning to those elements which are employed more for their colouring properties than for their opacifying power, *vanadium* may be instanced as having attained a wider use in the past few years. Vanadium oxides are used to produce a yellow glass, and a recent discovery, vanadium-tin yellow, is an exceptionally stable pigment. This consists of 2 or 3 per cent. vanadium pentoxide mixed with tin oxide and is a somewhat similar substance to the chrome-tin pink already mentioned. Two stains can be obtained with this pigment; a clean opaque yellow, and a strong, more or less transparent, greenish yellow, both of which can be used as glaze, underglaze, overglaze, and body stain at temperatures up to 1,400° C.

Selenium is important in that it produces the only pure red colour in vitreous enamels, glass enamels, and low-fired glazes. In combination with cadmium sulphide, selenium is used when a rich ruby red glass is required. Smaller quantities of the pigment give amber-coloured glass. In the process the glass must be reheated or annealed. Selenites and selenates of barium or sodium are also used in the ceramic industry in small quantities for decolorising glass.

Neodymium and *praseodymium* occur in small quantities in all cerium minerals. Neodymium oxide or oxalate is used to produce a delicate violet colour in glass. This colour, it is interesting to note, shows bluish in the thinner parts of the glass and reddish in the heavier parts. Praseodymium used in the same way produces a greenish yellow shade. The difficulty of separating the true elements and their high cost have prevented their extensive use in ceramics.

Despite its high price the element *uranium* finds quite a large use in the ceramic industry. A stain consisting of sodium uranate, alumina, and silica is employed in the manufacture of strongly-fired glazes to produce an ivory to yellow colour according to the quantity used. A brilliant tomato-red colour is obtained in low-fired lead glazes by the addition of 15 to 20 per cent. sodium uranate. Uranium oxide is also used to produce lustre or iridescence in glazed pottery, the colour being a greenish yellow. Glass stained with uranium oxide shows a wine yellow colour in transmitted light and a greenish yellow fluorescence in reflected light.

The last ten years have seen the rise to importance of nearly all of the colours and opacifiers described, and, although much progress has been made, the range of ceramic pigments is by no means complete. Research is still proceeding and doubtless, as time goes on, more and more new shades and colours will be added to the list, particularly as the lesser-known elements are produced in greater quantity and of a higher degree of purity.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

SOILS

Palestine.—The following extract from a report on the investigations carried out in the agricultural branch of the Central Laboratories of the Department of Health, Palestine, is contained in a statement furnished by the Acting Chief Secretary on work conducted during the half-year ended June 30, 1938.

" (i) *The Influence of Absorption-Ions and Neutral Salts on the pH of Soils.*—The author arrives at the following conclusions :

" The observation that the concentration value of *p*H in a soil is lowered on the addition of a neutral salt, is valid not only in the case of humid soils, but also in that of arid soils ; we must not speak of saturated and non-saturated soils, we can only discuss more or less saturated soils. All the processes which render humid climate soils unsaturated, take place also in arid climates, but much less intensively.

" Analytical data confirm the fact that the dilution of 1 : 5 and the shaking time according to Gedroiz (3 mins.) are giving optimal results.

" On the addition of a neutral salt, the concentration of *p*H diminishes most in the case of heavy soils, least—in that of light soils.

" A close relation exists between the position and valency of the absorbed complex and the concentration of *p*H in the soil.

" In comparing different types of soils, such as Ca, Mg, K and Na-soils it was observed that bivalent soils, i.e. Ca and Mg-soils, were less affected by the addition of neutral salts than the monovalent types, i.e. K and Na-soils ; also Ca-soil was less affected than Mg-soil, and K-soil less than Na-soil.

" The fact that the addition of a mineral fertiliser to the soil causes a diminution of the concentration of *p*H in the soil is of importance to the practical agriculturist. By examining the exchange of bases in the soil, he can arrive at an accurate estimate of the extent to which the soil would be affected by the addition of a mineral fertiliser, and what means should be taken (e.g. addition of lime) in order to prevent the accumulation of acids in the soil.

"The paper on this problem by M. Puffeles will appear in *Soil Research.*"

"(ii) *The Effect of Sheep and Goat Manure upon some Mediterranean Red Soils.*—The authors arrive at the following conclusions :

"The analyses of sheep and goat manure show that the composition is not materially affected by either the seasons or by the variation and manner of feeding. On drying the manure some loss of nitrogen is observed.

"The decomposition of the manure, as indicated by the C/N ratio, appears to have been completed in six months, under, of course, laboratory conditions, when keeping the soil with constant moisture content. The ratio of C/N of 'humus-like' substances and the increase of the value of exchangeable bases by the proportional increase of C are similar to those results obtained by other investigators.

"The addition of organic substances not only enhances the supply of nutritive as K, N, and P_2O_5 to the soils and improves in general their physical properties, but increases also their exchangeable bases.

"A paper on this problem by M. Puffeles and S. Adler has been submitted for publication."

Investigations concluded at the Jewish Agency Agricultural Research Station, Rehovoth, included a soil survey of the Beisan district, El Ghazawiya, Masil el Jizl, and Et Twal.

Investigations still in progress include:

(1) Continuation of the soil surveys.
(2) Salinification of heavy soils by irrigation.
(3) The movement of salts in heavy soils by drainage.
(4) The movement of potassium and phosphate fertilisers in irrigated red sandy soils.
(5) The absorption of ammonium ions from different fertilisers in different soils.
(6) The use of local turf as a manure.
(7) The storage of stable manure.

Results of investigations concluded are as under:

(1) Flood irrigation is found to be preferable to furrow irrigation where there is a danger of soil salinification by the upward migration of salts.

(2) Potassium sulphate added to irrigated red sandy soil in normal or double normal rations accumulates largely in the upper soil layer (0-30 cm.); 50-60 per cent. of this is slowly available, the remainder water-soluble or exchangeable.

(3) Application of phosphatic fertiliser in solution is preferable to application in solid form. Phosphorite was rendered soluble in red sandy soil by application in mixture with sulphur.

PESTS AND DISEASES

Palestine.—The Acting Chief Secretary has forwarded some notes on agricultural research conducted by Government and other institutions in Palestine during the half-year ended June 30, 1938, and the statements relating to pests and diseases are given below.

The following is an outline of the research work carried out by the Plant Protection Service of the Department of Agriculture and Fisheries during the period under review:

Research work during the last six months has been directed towards the further elucidation of the life history of *Empoasca lybica* (*benedettoi*). This should be completed by the end of the year when it is hoped that the results of the study of the virus alleged to be carried by this insect, now being conducted at the Potato Research Station at Cambridge will be available.

The life histories of *Carpocapsa pomonella*, *Prodenia litura*, and *Ceratitis capitata* are still under investigation, and the biology and control of *Capnodis* spp. also forms one of the major lines of research. *Eriosoma lanigerum* and its parasite *Aphelinus mali* are being studied. The latter survived the winter in several places. The survey of the pests of hill vegetables continues.

It is not expected to have any matter ready for publication before the autumn, when the timing of *Ceratitis* control measures in the Emek and the hills, and the control of *Prodenia* on fodder crops, and the biology and control of *Empoasca lybica* should all be ready for publication. Following work on a similar nature in Europe, an account of the control of plum saw fly by means of quassia spray will be ready for publication as a preliminary study, and the results of codling moth control in the Emek will also be available.

The following investigations have been in progress at the Division of Entomology of the Jewish Agency Agricultural Research Station, Rehovoth:

(1) Biology, ecology, and control of *Capnodis* spp.
(2) Ecological and physiological studies on the Mediterranean fruit fly.
(3) Biology and control of the grape moth.
(4) Biology of potato tuber moth.

(5) Life history of *Phyllopertha nazarena.*
(6) Life history of aphids attacking clover and alfalfa.
(7) Spraying experiments against scale insects attacking citrus.

The results of investigations carried out by the Division of Plant Pathology at the Jewish Agency Agricultural Research Station, Rehovoth, were as follows :

(1) It was found that Dothiorella rots of bananas and oranges are caused by the same fungus.

(2) The appearance of albino seedlings in citrus seed beds may be prevented by dipping the seeds in solutions of fungicides such as Uspulum and Ceresan, which contain mercury, or in solutions of salts of heavy metals as $HgCl_2$, $CuCl_2$, $NiCl_2$, $Co(NO_3)$, and PbCl.

(3) The optimum temperature for *Sclerotinia minor* blight of lettuce and bean was found to be 20-25° C. and the maximum 30° C. The fungus is not affected by copper sulphate and sulphur, but is killed by formalin and mercury compounds ($\frac{1}{4}$ per cent. sublimate, Uspulum, Ceresan and formalin).

(4) In the control of *Penicillium* and *Diplodia* wastage of oranges the best results were obtained by dipping the fruit in an 8 per cent. borax solution and rinsing them in water 24 hours later. Dipping the fruit in a 2 per cent. solution of NaOH proved effective against *Diplodia,* and, to a smaller extent, against *Penicillium.* As a rule the disinfectants were most effective on fruit treated soon after picking.

(5) A new method of controlling *Penicillium* and *Diplodia* wastage of oranges by placing a drop of disinfectant solution upon the stem end was found.

BEVERAGES

Cacao

Gold Coast.—The following statement relating to work on cacao conducted during the period January to June 1938 has been furnished by the Director of Agriculture.

Pathological Work.—Investigations into the cause of the curious malformations of the young vegetative growths in cacao have been continued, but so far the causative agent remains a mystery as the workers have been unable to find any parasitic organism in association with the swellings on new growths (c.f. this BULLETIN, 1937, **35**, 495). This lends further support to the theory of physiological causes being primarily responsible, and it would seem that where these obtain cacao is more subject to severe attacks of drought die-back which does ultimately cause the death of the trees. It is of interest to record that it has been observed that the swollen shoot phenomenon can and does occur on trees under good shade and showing no signs of die-back. Such trees have always, however, been found growing close to a die-back area in which the swollen growth symptoms are displayed.

In some localities excessive leaf-fall in the dry season is closely correlated with lack of overhead shade while the evergreen condition is associated with good shade protection. In other parts this is not the case—the deciduous habit, which is eventually followed by die-back, being sometimes found under conditions of shade, and the evergreen habit being often found where overhead shade is deficient. Such cases indicate that soil conditions, topography, or wind-breaks exert more effects on the general condition of the trees than direct overhead shade.

Investigations on the etiology of the swollen growth phenomenon have so far comprised:

- (i) the collecting of soil samples in:
    - (*a*) an area where swollen shoot and die-back exist together;
    - (*b*) an area where die-back exists without the swollen growths;
    - (*c*) an area where swollen growths exist without die-back; and
    - (*d*) an area where neither swollen growths nor die-back obtains.
- (ii) attempts at rooting cacao cuttings and subsequently transferring rooted cuttings to pots for experiments:
    - (*a*) on transmission of the affection by grafting;
    - (*b*) on the deficiency disease hypothesis; and
    - (*c*) on the possible causation of the swollen phenomenon by some unfavourable chemicals in the soil.
- (iii) repetition of attempts to isolate a pathogen.

Propagators of the "I.C.T.A." type were built for the purpose of rooting cuttings, attempts being made with infected and healthy material. So far, in spite of using Hortomone A, only a limited number of healthy cuttings have been rooted and these subsequently died on being transplanted into pots and transferred outside under shade. Experiments are now in progress on the effects of other growth-promoting substances —such as naphthalene acetic acid, phenyl acetic acid, and phenyl propionic acid—on the rooting of cacao cuttings. It appears to be necessary to induce the cuttings to root without loss of leaves, as otherwise the plants die when placed in the open, even beneath heavy shade.

Pests of Stored Cacao Beans.—Cacao sweepings infested with moth were collected from various commercial marketing centres and moths bred out for examination as to incidence of *Ephestia elutella* and *E. cautella,* using the system of classification adopted by Richards and Herford, i.e. on the structure of the genitalia. Of 378 moths examined all were found to be *E. cautella.*

SUGAR

Cane

Antigua.—The following statement relating to sugar cane experiments is taken from a report on investigation work carried out by the Department of Agriculture, Antigua, during the half-year ended December 31, 1938.

The experiments reported form a portion of a comprehensive series conducted by the Department and by Mr. C. F. Charter, Agronomist to the Gunthropes Estates, under the auspices of the Antigua Sugar Cane Investigation Committee and under the direction of Mr. P. E. Turner, Adviser in Sugar Cane Experiments to the Commissioner of Agriculture.

A complete report on these experiments will be published elsewhere in due course. Only those under the supervision of the Agricultural Department are here recorded.

The thanks of the Agricultural Superintendent are due to Mr. Turner for certain soil analyses, for statistical analysis of the results and for general advice and assistance in the preparation of the report.

Owing to lack of space it is only possible here to print the summary and discussion of the results. Tables giving details as to sites and layout of experiments and as to yield data have been furnished to the Imperial Institute and may be consulted by those interested.

Varietal Experiments

The results of the crops reaped in 1937 may be summarised as follows :

B 2935 has done well as a plant cane in every experiment reaped in 1937, filling the first place at Gaynors, High Point, Yeamans, and the better drained square at Jolly Hill. As a ratoon this variety has done well on the comparatively light calcareous soil at Collins and has failed on the heavy soils at Jolly Hill and at Parham New Work.

Ba 11569 has done well both as a plant cane and as a ratoon. Unfortunately it was not included in the varieties cultivated as first ratoons at Jolly Hill and at Parham New Work.

POJ 2878 has done well as a plant cane at Jolly Hill and as a ratoon on the heavy poorly drained soils at Sandersons, Jolly Hill, and Parham New Work during a year of exceptionally high rainfall.

B 147 has given comparatively poor results as a plant cane even when planted in October (B 147E at High Point). As a second ratoon at Collins it filled the fourth place, but was only 3 tons lower in yield than the leading variety. It was a complete failure at Jolly Hill and Parham New Work.

BH.10.12, although beaten by B 2935 and Ba 11569, has done well as a plant cane at Gaynors, Yeamans, and Jolly Hill during the wet season experienced. It has ratooned well at Collins and at Jolly Hill, but poorly at Sandersons and Parham New Work.

B 726 both as a plant cane and as a ratoon has been about equal to BH.10.12.

B 891 has done reasonably well both at High Point and at Gaynors, but at neither station is equal to the best varieties. It failed badly as a ratoon at Parham New Work.

S.C.12.4 has been included in all four of the ratoon experiments reaped in 1937. At each station it has been among the poorest varieties.

B 6308, an old variety, has ratooned well at Jolly Hill, but only poorly at Sandersons.

Varietal experiments have now been conducted on modern lines since 1933. The tables below give the summarised results of these experiments, and the discussion and recommendations which follow are based on these results and on field observations of the varieties in question. Certain small scale experiments reaped as plant canes in 1934 and as first ratoons in 1935 are not included in this summary as the layout was not entirely satisfactory. In the main, however, the results of these experiments were similar to those of the experiments here recorded.

Summary of Results of Varietal Experiments, 1933-1937

(Yield of canes in tons per acre; P.C.=Plant Canes; 1st R. and 2nd R.= First and Second Ratoons respectively.)

Soil Type: Fitches Clay

	Millars 1933.	Thibous 1935.	Collins 1935.	High Point 1937.	Gaynors 1937.	Total.	Mean.
Crop . . .	P.C.	P.C.	P.C.	P.C.	P.C.		
Rainfall (in.) . .	70·46	38·01	44·34	65·62	75·33	—	—
B 2935 . . .	—	16·1	28·8	49·5	63·4	157·8	39·4
Ba 11569 . .	36·5	17·2	28·1	46·1	55·5	183·4	36·7
POJ 2878 . .	52·5	13·1	25·2	37·4	55·3	183·5	36·7
B 147 . . .	24·6	7·7	22·3	37·2	42·2	134·0	26·8
BH.10.12 . .	36·2	—	26·3	—	53·5	116·0	38·7
S.C. 12.4 . .	36·4	10·7	22·5	—	—	69·6	23·2
B 726 . . .	—	—	22·2	—	51·9	74·1	37·0
B 891 . . .	—	—	—	41·8	—	41·8	41·8
B 417 . . .	38·9	—	—	—	—	38·9	38·9

	Millars 1934.	Thibous 1936.	Collins 1936.	Collins 1937.	Total.	Mean.
Crop	1st R.	1st R.	1st R.	2nd R.		
Rainfall (in.)	40·35	41·0	40·0	66·6	—	—
B 2935	—	24·3	20·5	22·2	67·0	22·3
Ba 11569	19·8	25·3	20·2	23·1	88·4	22·1
POJ 2878	22·5	22·8	14·5	21·0	80·8	20·2
B 147	23·1	17·9	19·8	20·1	80·9	20·2
BH.10.12	18·7	—	16·8	21·6	57·1	19·0
S.C.12.4	15·1	16·3	13·7	18·2	63·3	15·8
B 726	—	—	15·6	19·9	35·5	17·7
B 417	20·5	—	—	—	20·5	20·5

Soil Type : Calcareous Gunthorpes Clay

	Fitches Creek 1933.	Yeamans 1937.	Total.	Mean.	Fitches Creek 1934.
Crop	P.C.	P.C.			1st R.
Rainfall (in.)	68·9	74·7	—	—	42·9
B 2935	—	47·1	47·1	47·1	—
Ba 11569	39·1	45·0	84·1	42·05	18·9
POJ 2878	37·6	40·3	77·9	39·0	17·5
B 147	34·7	—	34·7	34·7	13·8
BH.10.12	35·6	42·3	77·9	39·0	14·0
G 140	34·2	—	34·2	34·2	12·5
POJ 213	32·4	—	32·4	32·4	14·9
B 891	—	42·0	42·0	42·0	—
B 726	—	44·3	44·3	44·3	—

Soil Type : Non-calcareous Gunthorpes Clay.

	Sandersons 1936.	Sandersons 1937.
Crop	P.C.	1st R.
Rainfall (in.)	45·82	82·46
Ba 11569	27·3	19·5
B 726	28·3	18·8
POJ 2878	22·7	23·4
BH.10.12	26·1	17·7
B 6308	21·3	17·6
S.C. 12.4	24·0	15·4

Soil Type : Lindsey Clay

	Parham New Work 1936.	Parham New Work 1937.
Crop	P.C.	1st R.
Rainfall (in.)	41·79	84·44
POJ 2878	27·3	14·2
B 2935	32·1	6·3
B 726	26·5	8·5
BH 10.12	26·4	8·6
G 119	27·5	7·1
B 891	27·2	5·4
S.C. 12.4	21·8	7·1
B 147	23·3	3·2

Soil Type: Alluvial

	Jolly Hill 1933.	Jolly Hill 1936.	Jolly Hill 1937.	Total.	Mean.	Jolly Hill 1934.	Jolly Hill 1937.	Total.	Mean.
Crop . . .	P.C.	P.C.	P.C.			1st R.	1st R.		
Rainfall (in.) .	58·98	37·61	86·53	—	—	39·77	78·29	—	—
POJ 2878 . .	23·6	35·0	43·5	102·1	34·0	20·8	31·5	52·3	26·1
BH.10.12 . .	20·1	31·4	40·2	91·7	30·6	16·5	25·9	42·4	21·2
B 726 . .	23·7	25·1	40·7	89·5	29·8	18·5	26·5	45·0	22·5
B 2935 . .	—	28·2	43·3	71·5	35·7	—	17·5	17·5	17·5
Ba 11569 . .	—	—	41·6	41·6	41·6	—	—	—	—
B 6308 . .	—	26·7	—	26·7	26·7	—	28·0	28·0	28·0
S C.12.4 . .	—	27·9	—	27·9	27·9	—	19·0	19·0	19·0
B 147 . .	—	21·7	—	21·7	21·7	—	13·0	13·0	13·0
B 891 . .	21·5	—	—	21·5	21·5	19·2	—	19·2	19·2
B 381 . .	20·3	—	—	20·3	20·3	17·3	—	17·3	17·3
B 374 . .	19·1	—	—	19·1	19·1	16·7	—	16·7	16·7

The general position as regards the varieties, based on the results of the last five years, may be summarised as follows:

Ba 11569 both as a plant cane and as a ratoon does well on most types of soil in Antigua, and, of the established varieties, is the nearest approach to a general purposes cane. It has not been cultivated to any extent on the alluvial soils, and on such soils will probably be found to be inferior to BH.10.12, B 726, and POJ 2878. It is a quick growing variety and stands drought well. Its juice qualities are moderately good. At times its germination is indifferent. Soaking in lime water for 48 hours, together with the use of young material taken from well-manured canes is helpful in this respect.[1]

B 2935 does well as a plant cane on all soil types, but as a ratoon is intolerant of poor drainage and is likely to fail on heavy soils. On the lighter calcareous soils it ratoons well and will probably beat any other of the standard varieties over a crop series (plant cane, first and second ratoons). Its juice qualities are only moderately good. It is usually a ready germinator.

B 147 (B 4507) has long had a reputation as a good cane for the lighter calcareous soils. It ratoons well and is drought resistant. It is intolerant of poorly drained soils, and must be established early. The germination of this variety is excellent if the cuttings are soaked for 48 hours in saturated lime water, otherwise germination may be indifferent unless soil moisture conditions are especially favourable. Its juice qualities are moderately good. In the experiments recorded above it has been beaten by B 2935 and Ba 11569, even on the type of soil

[1] G. F. Charter—private communications.

to which it is best suited and even when planted early (High Point, 1937).

BH.10.12 does well on alluvial soils—Fitches clays, calcareous Gunthorpes clays, and the more fertile Ottos clay soils—under conditions of fair rainfall. It is intolerant of poor drainage and dry situations. For the latter reason it is not generally suited to the calcareous soils of the East and North-East districts, but has done well in this region as a plant cane at Gaynors and as a second ratoon at Collins in 1937, a year of exceptional rainfall. BH.10.12 is a cane of excellent juice qualities. It is a ready germinator.

B 726 is a possible competitor of BH.10.12 on the soil types best suited to the latter. It is well suited to the alluvial soils of the Bendals and Jolly Hill areas. Like BH.10.12 it is a cane of excellent juice qualities and is a ready germinator.

POJ 2878 is well suited to the alluvial soils, especially in the Jolly Hill area where it has proved the best yielding cane both as a plant cane and as a ratoon in the experiments conducted during the past four years. This variety has done well in other parts of Antigua in years of exceptionally high and well distributed rainfall, but even under these conditions it has generally been beaten by B 2935 or Ba 11569. In normal years it is suited only to the wetter districts or to soils whose topographical situation renders them wet soils. It is a very easy cane to establish and makes rapid early growth. It is tolerant of poor drainage, but requires a plentiful supply of moisture throughout the growing period to give good yields. The percentage sucrose in the juice is fairly high, but the juice possesses certain undesirable qualities which make this cane poor from the factory point of view.

The above (together with Co 213, which is grown on certain shallow soils, on hillsides, in the North and North-East districts and on Tomlinson clays in the Paynters areas) may be regarded as the standard varieties now in general cultivation.

The following comments are made on the other varieties which have been included in these experiments.

B 891 does well on the calcareous soils, but is beaten by B 2935 and Ba 11569. It is a cane with excellent juice qualities. It does not ratoon well on heavy soils. It is very badly attacked by moth borer (*Diatrœa saccharalis*).

B 381 and B 374 were included in the experiment reaped at Jolly Hill as plant cane in 1933 and as first ratoon in 1934. These varieties were inferior to B 726, B 891, and BH.10.12 in juice qualities and did not exceed the latter in tonnage of cane and were omitted from subsequent experiments.

G 119 has done well at times on fertile and well-watered soils. It is a variety of poor juice qualities and is not recommended for extension.

G 140 and POJ 213 were included in the experiment at Fitches Creek, reaped as plant canes in 1933, and first ratoons in 1934. Mediocre in performance both for field and juice qualities, they have been omitted from subsequent experiments.

S.C.12.4 is not well suited to most Antigua soils.

B 6308 once a popular variety, has done well as a ratoon at Jolly Hill in 1937. It is, however, as a rule, inferior both from field and factory points of view.

Manurial and Cultural Experiments

Significant and considerable gains in yield have followed the application of pen manure to plant canes, both at Gaynors (1935) and at Pares and Cochranes (1936). Significant residual effects have been observed with the first ratoons at Pares and Cochranes and with first and second ratoons at Gaynors.

At Ottos, where a very small though statistically significant increase in yield of the plant cane crop resulted from the late application of pen manure, there was a larger significant residual effect on the first ratoons—the gain in yield being 3·8 tons per acre for 16 tons pen manure of rather poor quality.

At Thibous, where late applications of pen manure failed to give increased yields with plant canes, the residual effect was significant and considerable—the increased yield being 6·09 tons per acre.[1]

At Thibous also, late applications of filter press mud which failed to give increased yields with plant canes gave considerable and statistically significant increases with the first ratoons.

At Yeamans significant gains in yield from filter press mud and from pen manure were obtained with plant cane in 1935, and significant residual effects with ratoons in 1936 and 1937.

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[1] Applications of pen manure when made early are not invariably followed by economic gains in yield. In one experiment reaped in 1936 it was found that 20 tons good pen manure per acre gave only 1·35 tons per acre gain and it is suggested that satisfactory immediate gains in yield from pen manure depend on the previous manurial treatment, fields regularly manured in the past possessing a sufficient store of available phosphate for the early needs of the crop and thus responding, while in the case of fields not regularly manured in the past the store of available nutrients is low and pen manure is unlikely to release the necessary phosphate in available form until it is too late. ("Recent Investigations on Sugar Cane and Sugar Cane Soils in Antigua," Turner, Charter and Warneford, *Tropical Agriculture*, Vol. XIV, No. 5.)

At Carlisle and at Parrys experiments were reaped which were devised to measure the residual effect of a complete inorganic manure applied *late* to plant canes, both in the presence and absence of sulphate of ammonia applied to the ratoons. In neither experiment had significant increases been obtained with the plant cane crop, but at Parrys there was a statistically significant though small residual effect on the first ratoons.

It appears that the residual effect of pen manure and of filter press mud even when applied too late to the plant cane crop to produce an immediate increase may be considerable, but that the residual effect of an organic fertiliser supplying nitrogen phosphate and potash applied late may be statistically non-significant or only small although statistically significant.

Significant residual effects of sulphate of ammonia applied to the preceding crop have been recorded at Greencastle, Cochranes and Thomas', and at Collins. At Greencastle sulphate of ammonia had been applied to the plant cane crop on an alluvial soil in the presence of a basal dressing of pen manure and produced no immediate gains. At Cochranes and Thomas' sulphate of ammonia had been applied to plant canes on a calcareous Gunthorpes clay and caused no immediate gain in yield. At Collins the residual gain in yield was from sulphate of ammonia applied to the first ratoon crop.

At Carlisle and Parrys sulphate of ammonia applied to first ratoons in the experiment already quoted resulted in significant gains, on calcareous soils, of 2·42 tons per acre and 4·22 tons per acre respectively. At Long Lane and at Ffryes statistically significant gains in yield of plant canes resulted from applications of pen manure alone and in the presence of various combinations of inorganic fertilisers. At both stations the gains from pen manure alone were smaller than those resulting from a complete inorganic fertiliser alone, but the greatest increases in yield were obtained from pen manure plus a complete inorganic fertiliser.

A series of experiments without pen manure has also been reaped in which complete inorganic fertilisers and various combinations of inorganic fertilisers have been applied to plant canes. The following table summarises the results obtained in this series and in the absence of pen manure in the experiments at Ffryes and Long Lane already quoted.

Site.	Soil Type.	Period between planting and application of early manures.	Yields and Gains—Tons per acre.							
			No Manure.	N only.	Gain.	Complete Inorganic.	Gain.	Mean Gains from N.	Mean Gains from P.	Mean Gains from K.
Sandersons . .	G. non-calc.	8½ weeks	25·2	27·9	+2·7	35·6	+10·4	+3·7	+5·0	+1·4
Ffryes . . .	F.G. calc.	8½ ,,	48·1	50·6	+2·5	55·8	+ 7·7	+5·5	+1·3	+1·3
Millars . . .	F.	5½ ,,	43·5	50·3	+6·8	50·6	+ 7·1	+5·56	+0·81	+0·09
Long Lane . .	F.	7 ,,	37·0	40·5	+3·5	43·6	+ 6·6	+1·8	+2·1	+1·3
Bodkins . . .	G. calc.	11 ,,	40·8	44·9	+4·1	44·8	+ 4·0	+4·1	0·0	+0·3
La Roches . .	O. non-calc.	8½ ,,	38·9	—	—	42·9	+ 4·0	—	—	—
Diamond . .	F.	7 ,,	43·0	43·7	+0·7	46·9	+ 3·9	+0·74	+2·54	+0·09
Winthorpes . .	F.	20 ,,	32·8	33·4	+0·6	36·1	+ 3·3	+0·6	—	—
Langfords . .	F.	13 ,,	39·8	40·4	+0·6	42·1	+ 2·3	+1·17	+1·38	+0·01
Collins . . .	F.	7½ ,,	39·8	40·7	+0·9	41·9	+ 2·1	+1·4	+0·3	+1·6
Blackmans . .	F.	7½ ,,	33·3	32·7	−0·6	34·1	+ 0·8	−0·45	+1·23	+0·44
Jolly Hill . .	A.	8 ,,	48·4	49·5	+1·1	49·0	+ 0·6	+0·3	−0·34	+0·02

Soil Types : F. = Fitches Clay. G. = Gunthorpes Clay. O. = Ottos Clay. A. = Alluvial.

Considerable gains in yield have resulted from applications of sulphate of ammonia alone to calcareous soils at Millars and at Bodkins, and at both sites the resulting gains have equalled those produced by complete inorganic fertilisers.

At Sandersons, Long Lane and Ffryes, sulphate of ammonia alone has produced increases in yield, but the increases from complete inorganics have been considerably greater, and due also to phosphate and to a lesser extent to potash.

Considerable increases in yield have resulted from applications of complete inorganic fertilisers at Winthorpes and at La Roches. At the first-mentioned site sulphate of ammonia alone produced little increase, and at La Roches no treatment with sulphate of ammonia alone was included in the experiment.

At the Diamond there was little gain from sulphate of ammonia alone, and the increase of 3·9 tons per acre from the complete inorganic was due mainly to phosphate.

Small but statistically significant gains in yield from nitrogen and phosphate occurred at Langfords and from phosphate at Blackmans.

Small but statistically significant gains in yield resulted from the application of sulphate of ammonia in the presence of potash at Collins.

The results of experiments reaped in previous years have indicated that as a rule satisfactory gains in yield may be obtained by the application of sulphate of ammonia alone to non-calcareous or feebly calcareous soils in Antigua, but that on the calcareous soils an increase from nitrogen is only observed in the presence of an adequate supply of available phosphate which must be applied early in the life of the plant.

It is suggested that the response to nitrogen alone on certain calcareous soils in the season under review has been due to the greater availability of the soil phosphate as a result of the abnormally wet weather in 1936. Both the Bodkins and the Millars soils are retentive of moisture.

It is obvious that the previous manurial history of a field as well as the nature of the soil is an important factor is determining the nutritional status and consequently the response to fertilisers. At Sandersons, where the experimental site has been cropped for many seasons without manuring, the response to manurial applications has been larger, although the actual yield has been lower than in any of the other plant cane experiments reaped, the no-manure plots and the complete inorganic plots being respectively 25·2 and 35·6 tons per acre.

At Jolly Hill heavy yields have been obtained in all plots, viz., 48·4 to 49 tons per acre, but there has been no response to fertilisers. Although the previous history of the field indicates only irregular treatment with pen manure, the experimental site received an unusually thorough cultivation.

This fact, together with the heavy yield, would seem to indicate a high degree of fertility, under which condition a large response to additional nutritional elements could not be expected.

With respect to time of application of fertilisers, inorganics as a rule were applied within two months of planting, exceptions being at Bodkins, Langfords and Winthorpes. At Langfords the gains in yield were small; at Winthorpes, although rather larger—3·3 tons per acre—the variety cultivated, B 147 (B 4507), was one which makes very slow growth during the first few months. At Bodkins the increase has been due entirely to nitrogen, and as already suggested, is independent of early applications of soluble phosphate.

There are indications that the degree of response to fertilisers is dependent to a great extent on the soil moisture at time of application. It has not, however, been found possible to correlate response with rainfall at this period, since variations in moisture retention powers of the soils are important factors.

Three experiments with trash mulching were reaped during 1937. In the plant cane experiment at Winthorpes the gain from mulching in the absence of manures was small—1·5 tons per acre, but the gains in the presence of nitrogen only and in the presence of a complete inorganic manure were 3·8 tons and 6·1 tons respectively.

In the ratoon experiments the effect of trash mulching was not statistically significant. In neither experiment was sulphate of ammonia applied to the ratoons. Under such conditions the beneficial effect of trash mulching the plant canes does not extend to the ratoon crops. It is not improbable that there may be a conversion of soil nitrogen into a non-available form by the organisms which decompose the trash.

The present series of experiments, together with those already recorded, indicates that considerable immediate gains in yield can be obtained by the application of inorganic fertilisers to Antigua soils, and that these gains can exceed those resulting from an average application of pen manure.

The response to manurial treatment is dependent not only on soil type, but on previous manurial treatment and rainfall.

Nitrogenous manures alone may produce immediate and residual gains on certain non-calcareous soils. On calcareous soils, however, a response from nitrogen depends on the presence of an adequate supply of available phosphate. This must ordinarily be supplied by applications of soluble phosphate, but under certain conditions soil phosphate may be adequate.

On certain soils of low calcium carbonate content the gains from nitrogen are greatly increased by the application of other fertilisers, especially of phosphate, which on such soils may be fixed by calcium compounds other than calcium carbonate.

Potash appears to be needed on certain soils, but is of less general importance to plant canes than nitrogen and phosphate. The beneficial effect of phosphate depends on its being available to the plant in the early stages of growth.

The gains in yield from inorganic manures are considerably increased in the presence of a trash mulch, but the residual beneficial effect of the mulch may in certain circumstances be small.

St. Kitts.—The following summary of the results of varietal, manurial, and cultural field experiments with sugar cane reaped during the half-year ended June 30, 1938, and conducted by the Agricultural Department in co-operation with the Sugar Cane Investigation Committee of St. Kitts, has been furnished by Mr. R. E. Kelsick, Agricultural Superintendent.

Varietal Experiments.—B 2935 has proved far superior to the old variety S.C.12/4 both as a plant cane and as a ratoon on the dry areas. This variety was introduced by the Department from Barbados about four years ago and has done well on the dry lands of the Valley district. It has been found to be more suitable for these areas than POJ 2878, B 726, and BH.10.12.

Manurial and Cultural Experiments.—Applications of pen manure to plant canes at Buckleys and Molineux gave significantly higher yields than a mixture of artificial manures. At Buckleys the yields of the plots receiving artificials were considerably increased by the use of a megass mulch. In the first ratoons at Buckleys the pen manured plots again gave higher yields than the plots receiving artificials, while at Molineux those pen manured plots which had received no artificials in the ratoon crop gave significantly lower yields than the plots receiving artificial manures. The weather was extremely dry during the growth of the ratoon crop and the canes suffered from lack of moisture.

At Stapleton and Douglas a dressing of 30 tons of pen manure gave significantly higher yields than dressings of 10 and 20 tons per acre. In the first ratoon crop at Douglas no differences in yield were recorded from the different size dressings of pen manure to the plant canes, probably due to the effect of the very dry conditions which prevailed during the growth of the ratoon crop.

No gains were recorded from the use of phosphate at Estridges, Mt. Pleasant, Lavingtons, Bourkes, and Molineux.

Significant and considerable gains in yield have followed the application of potash to plant and ratoon canes at Belmont, Milliken, West Farm, and Molineux. The unpenmanured soils of the island have been found to respond readily to applications of potash.

At Canada a significant increase in yield of plant canes was recorded from the use of a 6 in. trash mulch.

At Mansion and Canada spacing the canes at 3 ft. in the row gave a moderately large and significant increase in the yield of plant canes over a spacing of 4½ ft. in the row.

No gains were recorded at Parsons and Hermitage from the cultivation of ratoon canes and at Belmont and West Farm from the cultivation of plant canes in addition to weeding.

At Buckleys the plots planted from November to March gave significant gains over plots planted in October.

FRUITS

Citrus

Dominica.—The following statement relating to work on citrus fruits carried out by the Agricultural Department, Dominica, during the half-year ended June 30, 1938, has been furnished by Mr. H. B. Pidduck, Acting Agricultural Superintendent.

Lime Breeding.—The long dry season retarded progress, but fruits of the recently produced hybrids are now being tested as they become available with a view to the elimination of those with a low degree of resistance to withertip disease or those which are obviously unsuitable to replace the West Indian lime. Attempts are also being made to obtain a Persian lime (Bear's Seedless) hybrid, but its almost complete seedlessness renders success very problematical.

Stock Trials for Limes.—Yields of limes budded on grapefruit stock continue to be higher than those on sour orange, which are only slightly better than those on rough lemon. A heavy crop, being the carry over from 1937, was obtained in January, and from the 10½ acres under bearing limes in this and other trials, over 180 barrels were reaped in that month.

Grapefruit and Orange Varieties.—Drought conditions in April and May caused the shedding of most of the summer crop, but the trees have since flowered profusely and give prospects of a fair late crop. One object of this trial is an attempt to find suitable early and late varieties in order to extend the season.

Government Fruit Farm.—Soil analyses carried out by Professor Hardy, of the Imperial College of Tropical Agriculture, having indicated a very satisfactory nutrient status in most of the citrus plots, the funds normally devoted to artificial manures have been applied to extension of windbreaks and cover crops. In plots found to be deficient in phosphate and lime, however, experiments are being continued to determine the optimum quantities required. This is a long term experiment and no tangible results are as yet forthcoming.

Plant Distribution.—Extensive irrigation and watering have had to be carried out in the citrus nurseries, and apart from rather slow growth, the plants look remarkably healthy. Distribution of budded citrus is expected to commence about mid-July and also the transplanting of sour orange rootstocks for budding for 1939. It has been made abundantly clear that of the two extremes, a protracted drought is preferable to excessive rains, provided there is a supply of water for irrigation, and humus in the soil. A surface mulch of dry vegetable matter is also desirable, and for this purpose lemongrass has proved useful.

Lime Experiment Station.—In addition to trials with West Indian limes budded on different rootstocks and planted at varying distances and on varying slopes, trials are also being conducted with limes top-worked on grapefruit budded on sour orange, Bear's Seedless limes similarly worked on Valencia orange, and West Indian limes planted under shade. These trials have been mentioned previously and at the moment there is nothing further to report. Their aim is to improve yields.

Top-Working of Citrus Trees.—As a result of an experiment commenced in 1934 to convert budded trees into some other species or variety of citrus, a routine technique has been evolved for the conversion of any undesirable type in the field without replanting, and during the past eight months the Department has assisted estates in this work, more particularly in the conversion of unsaleable seedy grapefruit to the Marsh Seedless variety and to Washington Navel oranges.

Montserrat.—Mr. W. E. Bassett, Curator of the Experimental Station, Montserrat, in his report on the work conducted during the period July to December 1937, states that good progress was made with the experiment planned to determine differences in the growth and yields of various plots of the West Indian lime budded on different stocks. The following root stocks are under trial: Sour Orange, Rough Lemon, and a local variety of orange known as "Seville" or "Silver Sweet." Material propagated in the experiment station was transplanted to the permanent site in September 1937, and all planting was completed within three days. The experiment involves 64 plants each of the West Indian lime budded on the three stocks mentioned above, and a similar number of

West Indian lime seedlings as "controls." The layout of the experiments is in the form of a Latin square and "guard" rows of seedling limes have been established between the "treatments." The area is mostly sheltered by windbreaks of *Pithecolobium unguis-cati.*

In a further report for the half-year ended June 30, 1938, Mr. Bassett states that a few of the trees in this experiment died during the period under review, presumably on account of being insufficiently well established to withstand the severe drought conditions experienced during several of the early months of the year. At the end of June most of the trees were looking well and were making flushes of new growth. Considerable injury by leaf-eating insects was evident. It is, of course, too early to make any comment on the effects of the various treatments.

Palestine.—According to a statement on agricultural research conducted in Palestine during the half-year ended June 30, 1938, furnished by the Acting Chief Secretary, the following investigations were being carried out by the Division of Horticultural Physiology and Genetics at the Jewish Agency Agricultural Research Station at Rehovoth, but no results are yet available:

(1) The use of the infiltration test of stomatal aperture as an indicator of the proper time for irrigation.

(2) The influence of stem girth of sweet lime stock saplings on the growth and yield of the Shamouti (Jaffa) orange.

(3) Breeding experiments on early and late ripening Shamouti (Jaffa) oranges.

(4) Investigation of the factors determining seed number in the Shamouti (Jaffa) orange.

The Division of Horticulture at the Jewish Agency Agricultural Research Station, Rehovoth, has been busy on the following problems:

(1) Effect of rootstock and scion on irrigation requirements on different soil types.

(2) Organic fertiliser requirements of citrus.

(3) Test of citrus varieties suitable for the Esdraelon Valley.

(4) Treatment of trees for the summer production of lemons.

(5) Planting distances for oranges.

The following extract relating to the utilisation of citrus by-products is taken from the Report on the Scientific Work of the Daniel Sieff Research Institute, Rehovoth, during the year April 1937-April 1938 :

" While the possibilities of the utilisation of orange juice have been investigated thoroughly before, the no less important question how to utilise the orange peel has been tackled during this year. Besides the obvious possibilities of preparing pectin and of extracting the essential oils, a new way has been found by the discovery that the peel contains about 40 per cent. (of its dry weight) of fermentable sugar. The fermentation by means of *Clostridium acetobutylicum* Weizmann has been studied ; the production of acetone and butyl alcohol takes place with excellent yields and high speed. It has been found that this is due to the presence of the necessary activators in surprisingly high amounts. Therefore the orange peel may conveniently be used for the acceleration of slow and incomplete fermentations as those of molasses.

" The above explanation of the easy fermentability of the orange peel carbohydrates has been made possible by the continued investigations on the activator problem in the Weizmann fermentation. It has been reported before that this fermentation requires a certain amount of asparagine, which is apparently used as a source of easily available nitrogen. More recent experiments point to the conclusion that the second activator which so far had not been identified is biotine, a factor which is recognised as a growth promoting substance for yeasts and other micro-organisms. Those results are in accordance with those for butyric acid and especially lactic acid fermentation. In the latter case, too, it has been found by Orla-Jensen that biotine is required besides a second factor which had been identified, also by investigations carried on in this Institute, as vitamin B_2. It may well be that the Weizmann bacterium also requires this vitamin, but that it is synthesised by the bacterium itself.

" With regard to the mechanism of the Weizmann fermentation, its similarities with and discrepancies from the butyric acid fermentation have been studied. That, up to a certain stage, both the reactions are identical is indicated by the observation that the course of the Weizmann fermentation too can be diverted with the production of lactic acid if it is carried out on sugar as substrate in an atmosphere of carbon monoxide. The statement made in last year's report in this connection was incorrect.

" The biochemical properties of the various strains, isolated previously, have been studied, especially with regard to the isolation and quantitative determination of intermediate products.

" On the lines of technical fermentation previous experiments with whey have been extended to include the fermentation of molasses-whey-mixtures by *Clostridium acetobutylicum* Weizmann. In presence of certain activators, like peanut meal, even relatively high concentrations of molasses in whey solution can be converted into acetone and butyl alcohol."

Tomatoes

Montserrat.—According to a report furnished by Mr. W. E. Bassett, Curator of the Experimental Station, Montserrat, on work carried out during the half-year ended June 30, 1938, a trial was laid down late last year to compare the growth habits and cropping qualities of two strains of tomato variety "Marglobe." The seed of one strain is much more expensive to purchase than that of the other. Results of the trial indicate that the strain of which the seed is more costly produces stronger plants of a more upright habit, carrying the fruit more clear of the ground, than do the plants from the cheaper seed. Also, the plants from the more expensive seed produce larger fruits, which are more uniform in shape, have tougher skins, and firmer and thicker flesh.

FORESTRY

TIMBERS

Nigeria.—Mr. J. H. Mackay, Assistant Conservator of Forests in charge of Forest Utilisation, in a report for the half-year January-June 1938, points out that progress in forest management demands the fuller utilisation of secondary timbers, and this in turn largely depends on the use of suitable timber preservatives. The Forest Utilisation Division has therefore entered on an investigation of the relative value of the principal wood preservatives, costs of treatment, absorption rates, and suitable method of treatment for different species. A timber testing laboratory has been erected with simple machines for comparative tests of the strength, toughness, and hardness of timber. Plant for carrying out machining tests is also being erected and a rapid survey of the strength, working qualities, and absorption capacities of all the common secondary timbers of Nigeria is now being made. This promises to disclose much useful information. An investigation of intensive exploitation of typical poor secondary forest is providing useful data on volume production, methods of extraction, and suitability of new species which are gradually finding markets. Conversion is at present by pitsaw, but the scheme provides a useful guide to the possibilities for small forest sawmills.

Trinidad.—Mr. R. L. Brooks, Conservator of Forests, in his half-yearly news letter for the first half of 1938, refers to the durability tests that are being undertaken with certain timbers. The second examination of the test pieces has been completed and again it has been found that fungus has been responsible for a considerably larger amount of damage amongst the untreated softer woods than termites. One interesting feature was the disappearance of *Coptotermes* from the graveyard in the Southern Watershed Reserve, and a general reduction in the termite population. Dr. Adamson, Professor of Entomology at the Imperial College of Tropical Agriculture, suggests three possible causes for this, viz. (*a*) the greatly increased presence of fungi may be unfavourable to attacks by *Heterotermes* and *Coptotermes*; (*b*) a large colony of *Coptotermes* may have died out; and (*c*) the drier conditions of the dry season may have reduced the number of termites in the upper layers of the soil.

None of the pieces treated with a mixture of creosote and crude oil by the hot and cold method were in any way damaged, whilst the 12 " Ascu " treated veneers of *Pinus longifolia* were still intact.

MINERAL RESOURCES

CYPRUS

The Imperial Institute has received from the Inspector of Mines and Labour the following report on mining activities in Cyprus during the first six months of 1938.

Both the production and export of cupreous pyrites showed a substantial increase for the first six months of 1938, compared with the corresponding period in the previous year.

Ore is now being exported from the Lymni and Kalavasso mines; the output from the latter is expected to increase considerably as soon as the new transport arrangements and loading plant come into operation.

The gold output shows an increase compared with the corresponding period in 1937, but there was a considerable falling off in returns from the Mathiati Mines which are now considered to be nearly exhausted. This is partly compensated for by an increased yield from the Mitsero Lease area.

There was very little activity in prospecting during the period.

Exports of asbestos fibre and terra-umbra showed a marked decrease compared with the preceding year.

MINERAL PRODUCTION AND EXPORT

	First 6 months 1938.	First 6 months 1937.
Cupreous pyrites (dry weight)	*Tons.*	*Tons.*
Skouriotissa Mine, production	97,237	110,931
,, ,, exported	109,023	105,910
Mavrovouni Mine, production	326,864	232,048
,, ,, exported	134,952	44,813
Lymni Mine, production	4,382	—
,, ,, exported	5,640	—
Kalavasso Lease, production	24,814	—
,, ,, exported	29,564	—
Mitsero Lease, production	991	—
,, ,, exported	—	—
Kambia-Sha Lease, production	120	—
,, ,, exported	—	—
Cupreous concentrates (dry weight)		
Mavrovouni ore, exported	55,084	39,264
Cement copper		
Lymni Mine, exported	—	—
Chrome iron ore		
Production	2,017	—
Exported	—	—
Gold (contained in ores, concentrates, and precipitates)	*Troy oz. fine.*	*Troy oz. fine.*
Skouriotissa Mine	3,623	602
Mathiati Lease	2,144	5,118
Akoliou Lease	530	1,563
M.W. Berdy Lease	350	794
Mitsero Lease Kalavasso Lease	2,233	—
Kellia-Avdhelero Lease	1,212	—
Prospecting Permit Areas	619	917
Total	10,711	8,994
Silver (contained in ores, concentrates, and precipitates)		
Skouriotissa Mine	20,303	3,064
Mathiati Lease	14,444	38,707
Akoliou Lease	1,944	5,924
M.W. Berdy Lease	1,750	3,016
Mitsero Lease Kalavasso Lease	15,530	—
Kellia-Avdhelero Lease	2,469	—
Prospecting Permit Areas	1,558	6,470
Total	57,998	57,181
Asbestos (Tunnel Asbestos Cement Co., Ltd.)	*Tons.*	*Tons.*
Rock mined	734,441	850,039
,, treated	265,601	130,115
Asbestos fibre produced	4,037	4,145
,, ,, exported	2,126	4,048
Other minerals exported		
Gypsum, calcined	1,617	2,061
,, raw	3,832	5,091
Stone, building, *cu. yds.*	*1*	*10*
,, pumice	53	2
Terra umbra	1,833	4,482
,, verte	1	10

GOLD COAST

The Imperial Institute has received the following statement from the Acting Director regarding the work carried out by the Geological Survey Department during the six months ended June 30, 1938.

During this period the detailed mapping of all but a small part of the Tarkwa goldfield and Nsuta manganese ore deposits and surrounding country was completed on a scale of 1 : 25,000, and a commencement was made of the underground examination of the working gold mines of the area. A narrow strip of country across the Birrimian-Tarkwaian and upper-lower Birrimian contacts between Bogosu and Dunkwa, and parts of eastern Sefwi, western Cape Coast, and northern Wassaw were geologically mapped and prospected.

Examinations were made of the surface and underground workings of most of the active gold mines in the Colony and Ashanti, and of the alluvial workings on the Birim and Bonsa diamond fields.

Tarkwa Goldfield.—The detailed mapping of the Tarkwa Goldfield has revealed that the large westerly displacement in the outcrop of the Banket from Aboso to Fanti is not, as previously thought, due to simple transverse faulting, but, primarily, to a complex swing in strike of the beds, accompanied by faulting, from the normal N.N.E. at Abosso and Fanti to nearly E.-W. in the intervening area. Several previously undiscovered faults have been located throughout the field, and the nature of the structure more closely defined.

Water Supply.—The work of the Water Supply Section was concentrated in western Dagomba, Northern Territories, where several ponds, dams, bilisi and wells were completed and many are under construction. It is yet too early to discuss the water-conserving efficiency of these projects.

Glasgow Exhibition.—Considerable time was spent in the preparation of geological specimens, maps and articles for the Gold Coast mineral resources exhibit at the Glasgow Exhibition.

Publications.—Bulletin No. 10, "The Geology of the Tarkwa Goldfield and Adjacent Country," was published, and a revised geological map of the Gold Coast on a scale of 1 : 1,000,000 was sent to the printers.

NYASALAND

The Imperial Institute has received the following statement from the Director of the Geological Survey regarding the work carried out during the period January to June 1938.

The present year is the fifth in which the geological and mineralogical work of the department has been carried out with the aid of a grant from the Colonial Development Fund.

The first half of 1938 has been occupied in part with the examination of specimens collected during the field season of 1937 and in the preparation of the relative reports and maps. The area dealt with has been mainly that lying around the southern end of Lake Nyasa and extending across the country from the western to the eastern border. Apart from several large tracts of recent alluvium, it is built up entirely of rocks of the Basement Complex, comprising quartzo-felspathic, biotitic and hornblendic gneisses, with local developments of graphite- and kyanite-gneiss and crystalline limestone, and intrusions of basic, intermediate, and, rarely, acid rocks.

In the Chikala-Namwera section of the area surveyed, gold colours were observed in stream concentrates at several localities, and further examination was made of a new occurrence of massive garnet, near the south-eastern end of Lake Nyasa. The garnet was examined at the Imperial Institute, but, while it occurs in considerable quantity, it proved to be too high in lime and too low in alumina for use under present conditions.

West of Lake Malombe and in Ncheu District additional observations were made on the deposits and old workings of mica, with which are associated minor occurrences of apatite.

The general examination of Ncheu District was completed, and in the course of this work a large new deposit of kyanite was recorded from between Dzonze Mountain and Kapiridimba on the Kirk Mountains plateau. The new deposit, samples from which have been examined and reported upon by the Imperial Institute, is of satisfactory commercial quality, and it has attracted the attention of a South African mining company. An extension of the Dzonze iron-ore deposits was observed, and samples have been sent for examination.

In the Dowa Lake shore area in which a group of wells was constructed there was recorded a new group of friable pebbly deposits that are possibly to be correlated with the Dinosaur Beds of North Nyasa. New pebbly sediments were disclosed also in the course of drilling operations on the Liwonde road near Balaka Station.

In the course of a reconnaissance of Central Shire District the common rocks of the Basement Complex of Southern Nyasaland were found to extend over this area; moreover, new minor occurrences of gold, graphite, corundum, zircon, rutile, and ilmenite were observed.

Papers have been prepared for publication on the early Cretaceous valley-form peneplain of the Nyasa-Shire and Luangwa-Zambezi system of troughs, on the fault-structures of the Shire rift, and on the application of these observations to the physiographical development of this region.

Reports and maps were prepared in connection with the Geological Survey drilling and well-sinking operations in Upper Shire, Dowa, and Lilongwe Districts, and water-samples from the wells and bore-holes have been analysed at the Imperial Institute.

The British South Africa Company continued its examination of the area in central Nyasaland over which it holds the mineral rights, and in the course of this work parts of Kota Kota, Dowa and Kasungu Districts were surveyed.

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IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO 3.

(April to June 1938)

Prepared in collaboration with the Imperial Institute of Entomology and the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

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Tests of New Vegetable Poisons from Plants that produce Essential Oils. By S. Kayumov. (In Russian.) *Sotz. Nauka Tekh.*, 1937, **5**, No. 6, 40-47. (*R.A.E.*, 1938, **26**, A, Pt. 5, 249.)

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The Incorporation of Direct with Protective Insecticides and Fungicides. III. The Factors affecting the Retention and Spray Residue of Emulsions and Combined Emulsion-suspensions. By E. Fajans and H. Martin. *J. Pom. Hort. Sci.*, 1938, **16**, No. 1, 14. Deals with the use of sulphite lye, a waste product of the paper-pulp industry as a spray adjuvant.

Quassin. III. Picrasmin. By E. P. Clark. *J. Amer. Chem. Soc.*, 1938, **60**, No. 5, 1146-1148.

Observaciones sobre el Uso del Quillay para Combatir los Coccidos y Áfidos. (Observations on the Use of Soap-bark for the Control of Coccids and Aphids.) By J. P. Canto. *Rev. Univ. Santiago*, 1937, **22**, No. 1, 131-132. (*R.A.E.*, **26**, A, Pt. 4, 221.)

NOTE.—The reference in brackets—*R.A.E.* etc.—which appears after certain items of the bibliography indicates the part and page of the *Review of Applied Entomology*, in which an abstract of the publication mentioned can be found.

NOTICES OF RECENT LITERATURE

Books for review should be addressed to " The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

THE SOUTH. ITS ECONOMIC-GEOGRAPHIC DEVELOPMENT. By A. E. Parkins. Pp. ix + 528, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1938.) Price 25*s.*

In the Preface to this work the author describes it as " an attempt to describe the civilization of the South, mainly in its economic-geographic aspects, and to interpret this civilization in terms of its regional setting and its historical antecedents." Within the wide scope of this field of survey Mr. Parkins presents a comprehensive and illuminating account of the Southern States of the American Union, dealing with their inhabitants, agriculture, industries, transport, climate, and natural resources, and with the social and economic problems that exist in this important and extremely interesting region of North America.

The volume is furnished with a good supply of maps, diagrams, statistical tables, and photographs, as well as an extensive bibliography.

SOILLESS GROWTH OF PLANTS. USE OF NUTRIENT SOLUTIONS, WATER, SAND, CINDERS, ETC. By Carleton Ellis and Miller W. Swaney. Pp. 155, 9 × 6. (New York: The Reinhold Publishing Corporation; London: Chapman & Hall, Ltd., 1938.) Price 13*s.* 6*d.*

During the past few years there have been considerable advances in our knowledge regarding the growth of plants in artificial media. The theoretical aspect of this work is a highly specialised study, but its practical applications come within the reach even of household plant culture.

This book, which is intended primarily for non-technical readers, gives an account of modern practice and possibilities in this field. It is essentially a practical approach throughout, giving numerous details of the methods employed, and of the media and apparatus required for different types of culture. There are a number of interesting photographs to supplement the descriptive matter.

By way of introduction the book opens with a chapter on the chemistry of plant life, after which the principal methods of soilless culture are discussed—sand culture, the sub-irrigation method, and water culture. There follows a chapter on growing fruit and vegetables on a small scale for the household and then a consideration of the commercial aspects of soilless culture.

The remainder of the book includes short discussions on auxins and certain accessory elements, plant diseases and physiological troubles, and finally gives a number of formulæ for nutrient solutions.

AGRICULTURAL ANALYSIS. A HANDBOOK OF METHODS EXCLUDING THOSE FOR SOILS. By C. Harold Wright, M.A., F.I.C. Pp. ix + 343, 8½ × 5½. (London: Thomas Murby & Co., 1938.) Price 16*s*.

The author of this book, formerly Senior Agricultural Chemist in Nigeria, had, in a previous post overseas, experienced all the disadvantages of being unable to consult more than a few scientific reference books and journals. To meet the needs of others similarly placed he set about the compilation of the essential particulars required by agricultural analysts, and more especially of those methods described in individual papers. The section on soils was issued under the title "Soil Analysis" in 1934 (see this BULLETIN, 1934, **32**, 337), and the present volume gives working details of the methods of analysis of fertilisers, feeding stuffs, milk and milk products, insecticides, and fungicides. The preparation of the indicators and the standard solutions used in the methods given is described and the data required for calculating the results are included in appendixes. Not only are the official methods prescribed by the Fertilisers and Feeding Stuffs Act given, but alternative ones are added for those who may be in a position to select the method to be employed. Author and subject indexes are included.

The book is well printed and arranged, and should be found very useful, not only by those for whom it was specially written, but will be welcomed by many other chemists more favourably situated, as it contains in one volume a collection of analytical methods for descriptions of which they have hitherto had to consult a large number of books or journals.

THE CHEMICAL ANALYSIS OF FOODS. By Henry Edward Cox, Ph.D., D.Sc., F.I.C. Second Edition. Pp. ix + 329, 8½ × 5½. (London: J. & A. Churchill, Ltd., 1938.) Price 21*s*.

Fully aware that it is impossible to deal adequately with the analysis of food in one small volume, the author has endeavoured to present the principles of this subject in a manner suitable to the requirements of chemists who are not experienced in this branch of chemistry. It is primarily a book for laboratory use, and the methods given are, with few exceptions, those which have been fully tried out and found reliable. The microscopy of food is not dealt with to any extent since this branch is sufficiently important to necessitate separate treatises.

While the layout of this second edition is identical with that of the first, advantage has been taken for a thorough revision and correction of errors, while much new material has been added. Particular attention has been given to methods for the determination of preservatives and metallic impurities, while a comprehensive scheme for the detection of prohibited colouring matters is given in an Appendix.

The new edition of this work, with its methods of analysis, useful analytical data, and frequent references to original papers, can be recommended to all those who wish to make themselves familiar with the recognised practice in food analysis.

THE SOYBEAN INDUSTRY. By A. A. Horvath, D.Sc. Pp. vi + 221, 8½ × 5½. (London: E. & F. N. Spon, Ltd., 1938.) Price 16*s*.

The author of this book spent some eight years or more in China acquiring first-hand knowledge of the soybean industry in that country and since then he has been continuing his studies of this product and its practical applications in the United States.

The soybean has become of increasing importance during recent years and its production in the United States has grown from 3 million bushels in 1920 to about 40 million bushels in 1935. Soybean oil is an important product in many industries, while the meal, in addition to being used as a feeding-stuff for animals, is utilised to a considerable extent in the manufacture of foods and industrial products.

In this volume will be found information relating to the different aspects of the soybean industry. Chapters are devoted to a description of the methods employed for the preparation of the oil from the beans and the respective advantages and disadvantages of the hydraulic, expeller, and solvent extraction processes are enumerated. The refining of the oil to render it suitable for use as an edible oil in such products as margarine and mayonnaise, its hydrogenation to fit it to be an ingredient of shortenings and lard substitutes, and its various other uses such as for paint and soap manufacture are dealt with in succeeding pages. Methods for the extraction of phosphatides (e.g. lecithin) are described and reference is made to the preparation from soybeans of those now available commercially and their utilisation in the butter, margarine, paint, soap and other industries. Protein is a most important constituent of soybeans, being present to the extent of about 40 per cent. Soybeans on this account have of recent years found new uses. The properties of this protein are enumerated and its preparation on a commercial scale described, as is also its use in the plastics industry and for adhesive and sizing purposes.

CRYPTOGAMIC BOTANY. By Gilbert M. Smith. Volume I. ALGAE AND FUNGI. Pp. viii + 545, 9 × 6. Price 24*s*. Volume II. BRYOPHYTES AND PTERIDOPHYTES. Pp. vii + 380, 9 × 6. Price 18*s*. (London: McGraw-Hill Publishing Company, Ltd., 1938.)

This work gives an account of the structure, reproduction, classification, and phylogeny of spore-bearing plants. It is obvious that so wide a field cannot be covered fully within the limited space of two volumes, yet, by selecting typical representatives of the different groups, the author has succeeded in giving a wealth of detail without losing a clear perspective view of the broader classification. The merits of a reference work and a general text-book for students are thus combined in one, while for those who wish to make a more detailed study on any group there is a lengthy bibliography included at the end of each chapter. Finally, mention must be made of the numerous illustrations which by their excellence greatly add to the value of the book.

METAL-MINING ENTERPRISE. By Professor S. J. Truscott, D.Sc., A.R.S.M., M.Inst.M.M. Warington Smyth Memorial Lecture, 1938. Pp. 38, 8½ × 5½. (London: Macmillan & Co., Ltd., 1938.) Price 1*s*.

Some time ago the authorities at the Imperial College decided to hold the Huxley memorial lectures biennially and to dedicate the discourses of intervening years to other distinguished ex-professors of the college. In pursuance of this policy Sir Warington Smyth, who occupied the chair of Mining from 1851 to 1890 at the Government School of Mines (afterwards to become the Royal School of Mines), was commemorated by a discourse given by Professor S. J. Truscott on May 5th, 1938, entitled "Metal-Mining Enterprise."

In the course of his address the lecturer reviewed man's early use of metals, passing progressively to the present annual production of new metal.

Dealing with technological enterprise, Professor Truscott observed that the El Dorado of the past is not so likely to be discovered in the future, it will therefore become necessary to find and work poorer, more difficult, and less obvious deposits at a cost the world can pay. Such considerable masses will have to be handled, that mining will mean engineering in a closer sense than before, and farther removed from romance; and so in the end useful deposits will, in a sense, be made rather than found.

Modern prospecting is mainly financed from community centres and directed by mining geologists; for penetration into otherwise inaccessible areas and for the quick mapping of unmapped areas the aeroplane is used; for the closer investigation of selected areas geophysical measuring instruments are called upon to serve; and for the final ascertainment the diamond drill or equivalent appliance comes into action. Drills to-day have reached depths beyond 9,000 ft. direct from the surface in search of metal.

The skilled miner is now largely a skilled machine operator, and the mine almost like a factory. Mechanical shovels on surface now remove as much as 40 tons of rock at a scoop. Enormous chain-bucket excavators moving on rails, cut and bring to the surface in one continuous operation such large quantities that the resultant excavations make the largest graving-dock look small. Dredges are used nowadays of such capacity that the resultant production cost is low enough to permit the profitable recovery of one part of tin oxide in 5,000 parts of detritus, and one part of gold in 5 million.

Underground, the works are no less impressive. There are shafts which in a single descent drop more than 6,000 ft. direct, with appropriate receptacles for men, materials, and mineral, moving up and down at express speed. Where the deposit continues deeper than the first direct descent, a new mine, so to speak, is laid out, beginning from that deep horizon, having its own underground winding engines, its own interior shafts, and its transfer stations, to the mine above. In this manner the miner is in touch with depths greater than 8,000 ft., and going still deeper.

On the surface, blasts of as much as 50 tons of explosive have broken ten thousand times that amount of ground for removal, none being blown sky-high nor scattered. In this work liquid oxygen sometimes competes with the more common nitro-glycerine explosives.

Underground, but yet not deep, masses of ore up to even a million tons have, after systematic and adequate undercutting by explosive, been invited to break themselves, expenditure upon explosive being thereby saved. In deeper ground, economy in the use of explosive is obtained by blasting in holes as deep as the dimensions of the deposit allow, the spacing and directing of the holes being to a determined pattern.

In very deep mines the weight above makes even the hardest rock virtually brittle, and breaking becomes a concern subordinate to that of the support necessary to keep the workings open. Great quantities of air have to be circulated—so great, indeed, that the weight of fresh air sent down becomes a multiple of the weight of ore brought up.

In conclusion, the standard to which enterprise in mining technology has attained to-day may be gauged from the facts that on a vast scale and without fuss one part of gold is being won with profit from 200,000 parts of solid rock, and one part of platinum from a million—figures comparable to those pertaining to the extraction of radium.

MINES REGISTER. SUCCESSOR TO THE MINES HANDBOOK AND THE COPPER HANDBOOK. Vol. XIX, 1937. Pp. 282 + 1340, 9 × 6. (New York: Mines Publications, Inc.) Price $25.00.

The scope of this comprehensive work is indicated by the sub-title: "Describing the non-ferrous metal mining companies in the Western Hemisphere."

The last issue of The Mines Handbook (Vol. XVIII) appeared in two parts in 1931. In spite of a considerable increase in the subject matter, the use of smaller type has now rendered possible the issue of this publication in one large volume. The new edition is claimed to be a complete revision of the old one and to contain not only descriptions of over 4,000 active mining companies, but also references to more than 15,000 inactive ones.

The principal change made is that instead of the former practice of classifying the companies according to countries they are now arranged alphabetically in one list. This may be of advantage to those who know the exact name of the company sought, but for those wishing to ascertain the principal mining companies in Peru, for example, the usefulness of the old Mines Handbook is lost.

Some useful features added to this edition include a short section dealing with the leading non-ferrous metal mining companies in the Eastern Hemisphere, an alphabetical list of mining officers and directors, and an enlarged statistical section.

MINERAL TABLES FOR THE DETERMINATION OF MINERALS BY THEIR PHYSICAL PROPERTIES. By Arthur S. Eakle. Third Edition, revised, by Adolf Pabst. Pp. v + 73, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1938.) Price *7s. 6d.*

The third edition of the Eakle Tables, the first edition of which was published in 1904, has been revised by A. Pabst, also of the University of California, and now contains descriptions of about 200 minerals. The tables are based wholly upon physical properties and the only apparatus needed for the determination of minerals with their aid is a streak plate or a piece of unglazed porcelain, a pocket-knife, a horseshoe magnet, a pocket lens, and a set of minerals for testing hardness.

The book commences with a short section of seven pages summarising the physical properties of minerals, the remainder being devoted to the tables themselves. The minerals are first classified into six groups according to their streak, the sixth group (streak uncoloured, white, or light grey), however, occupying 40 of the 58 pages. Each group is subdivided according to colour, the minerals being arranged in order of hardness in each colour section. An analytical key refers directly to the colour sections. Owing to this primary classification according to streak and colour many minerals appear several times in the tables. Each entry gives the mineral name, its chemical formula, colour, streak, lustre, hardness, crystal system, cleavage or fracture, specific gravity, common structure and short observations. Some difficulty may be experienced in appreciating the various shades of colour attributed to certain minerals: they vary from horse-flesh brown to oil-green, and at least 20 shades of brown are mentioned.

Tables such as the author has compiled naturally have their limitations from a mineral determinative standpoint, but, nevertheless, should be of value to the knowledgeable prospector.

THE PRINCIPLES OF MOTOR FUEL PREPARATION AND APPLICATION. By Alfred W. Nash, M.Sc., M.I.Mech.E., M.I.Chem.E., F.C.S., F.Inst.Fuel, and Donald A. Howes, D.Sc., M.I.P.T. Volume I. Second Edition. Pp. xiv + 628, 9¾ × 6¼. (London: Chapman & Hall, Ltd., 1938.) Price 36*s*.

There are few industries in which such rapid advance is made as in that concerned with the preparation of petroleum, and the vast amount of technical research done each year quickly renders the most authoritative of textbooks on the subject obsolete. Thus, within four years of its first publication, Vol. I of the book by Professor Nash and Dr. Howes, which was noticed in this BULLETIN, 1934, **32**, 630, has appeared in a second edition.

The principal change in the new volume is the inclusion of a long section on pyrolysis and polymerisation, which becomes Chapter VIII, though the number of chapters has been retained at ten by coalescing the first two chapters, which were devoted to the principles of distillation (Chapter I) and to the production of motor fuels from petroleum by distillation (Chapter II), under the title "the principles and practice of distillation." Changes have also been made in the typography of the headings with a considerable degree of improvement in the clarity of the text, and the small number of printer's errors of the first edition have been corrected.

It is, however, unfortunate that the authors have not thought fit to amend the many statements qualified by the word "recently" which occurred in the first edition and now reappear unaltered after an interval of four years. Furthermore, the few statistical tables included are sadly out of date for no apparent reason, particularly the table on p. 310 dealing with the production of benzole by countries, the latest figures in which relate to 1933, though 1936 statistics were available at the time of revision. The allegation on p. 286 that road transport is uneconomic as compared with rail because "the rail car can carry at least twice as much as the road lorry," and because of "the reduced rail rates" is unwarranted. The normal type of railway tank waggon has a carrying capacity of 12 tons and the bulk road transport vehicle a capacity of at least 10 tons; the second statement was evidently written before the railway rates were increased by 5 per cent. in 1937. These are but minor points, however, in a work of such scope as this.

Additions include in Chapter I a comprehensive account of the modern pipe still; in Chapter II accounts of the Tube and Tank, De Florez, and True Vapour Phase cracking processes; in Chapter V an enlarged and up-to-date treatment of the section on oil duties in the United Kingdom; in Chapter VII an enlarged section on the Imperial Chemical Industries hydrogenation process at Billingham; and in Chapter X augmented accounts of the shale oil industry in Scotland and in the Union of South Africa; a completely rewritten section on the use of tar oils and creosote as fuels for internal combustion engines, and a new section on the Fischer-Tropsch process.

The book has been further improved by several new plates, which together with the many additions already referred to, and the still more extensive bibliographies and indexes, make it one of the most valuable and fundamental works on the subject of motor fuels.

BOOKS RECEIVED FOR NOTICE

THE STRUGGLE FOR IMPERIAL UNITY (1868-1895). By J. E. Tyler, M.A. Royal Empire Society Imperial Studies, No. 16. Pp. viii + 219, 8½ × 5½. (London, New York, Toronto: Longmans, Green & Co., Ltd., 1938.) Price 12*s.* 6*d.*

OVERSEAS TRADE AND EXPORT PRACTICE. By G. T. MacEwan, M.I.Ex. Pp. xvi + 366, 8½ × 5½. (London: Macdonald & Evans, 1938.) Price 12*s.* 6*d.*

TRANSACTIONS OF THE BOSE RESEARCH INSTITUTE, CALCUTTA. Vol. XI, 1935-36. Biological and Physical Researches. Edited by Sir Jagadis Chunder Bose, M.A., D.Sc., LL.D., F.R.S., C.S.I., C.I.E. Pp. vi + 190, 8¾ × 5½. (London, New York, Toronto: Longmans, Green & Co., Ltd., 1938.) Price 18*s.*

BIBLIOGRAPHY OF SOIL SCIENCE, FERTILIZERS AND GENERAL AGRONOMY, 1934-1937. Pp. xv + 540, 7½ × 4¾. (Harpenden: Imperial Bureau of Soil Science, 1938.) Price 25*s.*

THE PRINCIPLES OF SOIL SCIENCE. By Alexius A. J. de Sigmond, Ph.D., translated from the Hungarian by Arthur B. Yolland, B.A., Ph.D., Translation edited by G. V. Jacks, M.A., B.Sc. Pp. xiv + 362, 9¼ × 6¼. (London: Thomas Murby & Co., 1938.) Price 22*s.* 6*d.*

THE STUDY OF THE SOIL IN THE FIELD. By G. R. Clarke, B.Sc., M.A. Second Edition. Pp. 192, 6¾ × 4½. (Oxford: The Clarendon Press, 1938.) Price 6*s.*

THE SOILS OF PALESTINE. By A. Reifenberg, Ph.D., Dipl.Agric. Translated by C. L. Whittles, M.A., Ph.D. Pp. viii + 131, 8½ × 5½. (London: Thomas Murby & Co., 1938.) Price 14*s.*

CANE SUGAR PRODUCTION, 1912-1937. By H. C. Prinsen Geerligs, Ph.D., and R. J Prinsen Geerligs. Pp. xi + 164, 9¾ × 7. (London: Norman Rodger, 1938.) Price 10*s.*

THE FRAMEWORKING OF FRUIT TREES. By R. J. Garner, N.D.H., Dip. Hort. Sci., and W. F. Walker. Pp. 19, 9¾ × 7¼. Imperial Bureau of Horticulture and Plantation Crops, Occasional Paper No. 5. (East Malling, Kent: Imperial Bureau of Horticulture and Plantation Crops, East Malling Research Station, 1938.) Price 1*s.*

UTILIZATION OF FATS. By H. K. Dean, B.Sc., Ph.D., A.I.C. Pp. xiv + 292, 9½ × 6. (London: A. Harvey; New York: Chemical Publishing Co. of New York, Inc.; Toronto: Westman Publications, Ltd., 1938.) Price 15*s.*

DIRECTORY OF PAPER MAKERS OF GREAT BRITAIN AND IRELAND FOR 1938. Pp. xix + 307, 10¼ × 7¼. (London: Marchant Singer & Co., 1938.) Price 5*s.*

THE BLACK POPLARS AND THEIR HYBRIDS CULTIVATED IN BRITAIN. By G. S. Cansdale and members of the staff of the Imperial Forestry Institute. Pp. 52, 8½ × 5½. (Oxford: The University Press, 1938.) Price 3*s.* 6*d.*

COMMERCIAL MAHOGANIES AND ALLIED TIMBERS. By B. J. Rendle, B.Sc., A.R.C.S. Pp. vi + 46, 9½ × 6. Department of Scientific and Industrial Research, Forest Products Research Bulletin No. 18. (London: His Majesty's Stationery Office, 1938.) Price 2*s.*

HEREDITY. By A. Franklin Shull. Third Edition. Pp. xvii + 442, 9 × 6. (London: McGraw-Hill Publishing Company, Ltd., 1938.) Price 21*s.*

ALLUVIAL PROSPECTING AND MINING. By S. V. Griffith. Pp. x + 142, 8¾ × 6. (London: Mining Publications, Ltd., 1938.) Price 12*s.* 6*d.*

THE ECONOMICS OF THE SULFURIC ACID INDUSTRY. By Theodore J. Kreps. Pp. xiii + 284, 8¾ × 6. (California: Stanford University Press; London: Humphrey Milford, Oxford University Press, 1938.) Price 23*s.*

BULLETIN
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EMPIRE SERVICE AT THE IMPERIAL INSTITUTE: HOW CANADA BENEFITS

By SIR HARRY LINDSAY, K.C.I.E., C.B.E.
Director of the Imperial Institute

A talk broadcast to Canadian listeners from Edmonton, Alberta, on September 8, 1938.

THE British Empire was built up by individualists and all Empire-lovers are individualists at heart. Now the danger with the individualist is just this, that he is far too inclined to say " Don't you come and bother me—let me get on with my job." It was just the man who got on with his job and who was more concerned with practice than with theory, who built up this Empire of ours. But, after all, it is far more exciting to help build up an Empire than merely to help run it successfully, just as it is far more exciting to build up a fortune than to see that it is wisely and soundly spent. More co-operation, more thoughtfulness, more self-restraint, yes, and even more patient and dogged courage, are demanded of us Empire citizens, whether we be Canadian, English, or Scottish, if we are to carry on the fine traditions which built up the Empire and to pass on our heritage to future generations not merely undiminished but invigorated and ennobled.

I think something of that sort must have been in the mind of your Dominion Prime Minister, Mr. Mackenzie King, when he used in a speech the other day the phrase, " Bonds of Freedom," a phrase so illuminating that it should always be remembered. Every individual has his right to freedom—

that is fundamental throughout the British Empire. We are all proud of our freedom and we regard it as our birthright. But we are sometimes tempted to forget all the implications of freedom; to forget, for example, that our neighbour's freedom is just as sacred to him as ours is to us, and that occasions may arise when the two freedoms tend to clash. What is to happen then?

Well, that is where the "Bonds of Freedom" come in. Every right has its countervailing responsibility and every liberty has its countervailing service. If I am really to respect my neighbour's freedom I must often be in the position of serving him, for service is the key to neighbourliness.

I have given the title of Empire Service to this broadcast talk because I hold very strongly the belief that "service" is the secret to all right Empire thinking. It is certainly our motto at the Imperial Institute. Our work there—our service to the Empire—is twofold. First of all we bring together all the scientific information which we can obtain to help on the development of the natural resources of the Empire. That is our Scientific side. The other side of our work is Educational; I will explain that later. To take our scientific work first. Here, as I said a moment ago, our chief function is to bring together in one centre all the technical information we can get about the development of the natural resources of the Empire. Animal, vegetable, or mineral, all raw materials come within our scope; and during the fifty odd years of our existence we have managed to build up a mass of useful information about Empire resources, some of it from investigational work by the forty technical experts whom we employ in our laboratories and market intelligence and statistical offices; some of it collected on index cards from technical journals published in many different languages all over the world, but particularly from all countries of the Empire. I don't suppose that there is any single Scientific Library within the Empire which comprises so much information as we have on record regarding raw materials of all classes and kinds.

This is the source from which we answer inquiries addressed to us at the Imperial Institute every day and all day long from all over the Empire. So far as Canada is concerned, it is true that the Hon. Vincent Massey, your High Commissioner in London, and Mr. Frederic Hudd, your Trade Commissioner, are well able to look after all trade inquiries from Canada. Nevertheless, there are some which we are specially equipped to handle, with our laboratories and our Empire-wide connections, and here we co-operate with the authorities at Canada House.

Let me give you a few instances illustrating the range of problems with which we deal: Firstly, the production within the Empire of raw materials hitherto available only from foreign countries. Secondly, the utilisation of Empire by-products hitherto regarded as waste products. Thirdly, the adoption of new and improved methods of cultivation or of processing Empire materials, or of packing them for transport. Fourthly, the discovery of new markets for Empire products, whether within or outside the Empire.

Now let me turn to practical illustrations of the scientific work which we do for Canada, quoted from our records of the past year or two. A large number relate to timber and forest products generally. In addition, let me quote the development of new raw materials for paper-making, the analysis of gums and resins; the commercial possibilities in Canada of products such as soya beans, cascara bark, ramie; the production and uses of flax; and, again, on the minerals side the development in Canada of bismuth, lithium, molybdenite, and helium gas; analyses of the Lake Superior iron ores; the production of magnesium silicate concentrate in Canada, of mercury in British Columbia, of chrome, talc, lepidolite, bentonite; of manganese from Cape Breton Island; of chrome; of nickel and its by-products; of copper, asbestos, beryllium, radium. These are a few out of many examples of the technical work which we carry out on behalf of Canadian producers.

To help us with this scientific work we are fortunate in having the assistance of two Advisory Councils, one on Plant and Animal Products under the chairmanship of Sir Frank Stockdale, and one on Mineral Resources with Sir William Larke as chairman. Dr. C. Camsell, the Deputy Minister for Mines in your Dominion Government, represents Canada on our Mineral Resources Council. In addition, we have appointed Consultative Committees, fifteen in all, comprising business men, scientists, technical experts, and official representatives of many different Governments of the Empire. These Committees advise us on each of the major classes of raw materials, such as Timbers, Hides and Skins, Precious Metals, Base Metals, and so on. Mr. R. J. Hutchinson, Chief of the Fibres Division of the Agricultural Department of your Dominion Government, is a member of our new Empire Flax Sub-Committee and represents Canada on that body.

Now let me turn from Science to Art, for Education is in itself an Art and some of the work which we carry out at the Imperial Institute on behalf of Canada is of great educational importance. From this aspect, we like to think of the Imperial Institute as a Storyland of the Empire, for in our Galleries and Cinema and by means of our great Empire Film Library we tell the story of the Empire as one of our daily tasks to thousands of school children throughout the United Kingdom.

To take the Exhibition Galleries first, these are four in number, and they run east, west, south, and north, and measure in all between a quarter and half a mile in length. Each Gallery is divided into Empire Courts and each Court tells the story of a country of the Empire. Every Dominion and every Colony, even the smallest of them, has its own Court. And the Courts are so arranged that they run in their natural geographical sequence round the world. Canada has the largest Court, for it occupies a whole Gallery to itself, the West Gallery. India, Burma, and Ceylon occupy the East Gallery. The South Gallery comprises the West Indies, New Zealand, the Pacific Islands, Australia, and Malaya ; and the North Gallery the Mediterranean and African Colonies and the Union of South Africa. Newfoundland fits in between Canada and the West Indies. So you see every part of the Overseas Empire is included.

In these Courts we tell the story of each Dominion or Colony or Protectorate by means of photographs and dioramas and economic specimens, so that a visitor to the Court finds himself standing, in imagination, in the country itself, admiring its natural scenery, watching its agriculture and industries and the life of its people at work and play. One of the greatest of our problems in these Galleries is, how to tell accurately and yet also attractively the story of the development of the natural resources of each Empire country ; in other words, to employ every possible device of Art in the description of scientific fact. Here we have gladly borrowed the latest technique adopted in the museums of both continents, America and Europe. We have broken away from the old out-of-date method of putting specimens in spirit, labelling them and leaving them at that. Instead, we tell the whole story of the particular industry concerned, from the raw material to the finished products. For example, in the Canadian Court we trace the story of nickel from the ore as it is mined, with photographs of the mining and smelting processes, right through to the manifold modern uses of nickel and its by-products ; so also Canadian asbestos, from the mine to the latest type of asbestos cements or bricks or boards or the new fire-fighting suits made of textile asbestos ; or the story of the conversion of Canadian wheat into flour. Each of these stories if properly conceived and set out can become a real fairy-story, a picture-book, so to speak, of modern agriculture, mineral, and industrial development. They say that Romance and Adventure are the mainsprings of modern scientific achievement. Well, by means of these new types of exhibits in our Exhibition Galleries at the Imperial Institute we tell the story of each of the premier Empire industries, a story in which Art and Science, Romance and Adventure, are skilfully combined.

The Canadian Court was equipped in 1929 by means of a grant of $25,000 from your Dominion Government ; but it is getting a bit out of date now and I am hoping that, as a result of my visit, a special effort will be possible to bring this magnificent Court completely up to date and to maintain it in a manner and style worthy of your great Dominion.

In our Cinema Hall, again, we tell the story of the Empire by means of Empire films, originally collected by the Empire Marketing Board of blessed memory and since supplemented by gifts of films from Empire Governments and commercial, travel, or industrial organisations. Over half a million of the general public of the United Kingdom visit our Galleries and Cinema every year.

But the Galleries and Cinema are naturally most easily available to the London public. Our Film Library lends Empire films to schools and societies throughout the whole of the United Kingdom at no charge save to recover the postal expenses.

Now this is a very fine Empire service, for it brings home to the rising generation of the United Kingdom pictures of the life, scenery, and natural resources of the Empire. It gets the Empire story across in a more vivid and living way than perhaps any other form of visual instruction. And how does Canada figure in this service? Well, after the United Kingdom Section, the Canadian Section in our Film Library is larger than any other. Of 1,600 Empire films which comprise the Library, 300 are Canadian. By this means over 1,400,000 persons, adults and juveniles, in the United Kingdom, saw our Canadian films last year. That is a big number and it shows what a powerful influence the Empire Film Library is in telling the story of Canada to the United Kingdom.

Just one more word before I close. I am very anxious to secure still more films of Canada for this Library. I spent all last week at Toronto and the last two days at Winnipeg in bringing our need of films to the notice of the Governments and business circles in both centres. Canadian films are very popular with the schools of Great Britain and some of our best films of Canada are booked weeks or even months ahead. I could double our existing stock of 300 Canadian films and yet fail to satisfy all the demands we get. I am quite sure that in this matter I shall secure the co-operation of all who are in a position to supply us with good films and so to help us to extend and develop this Empire service which we render in making Canada better known throughout the United Kingdom. I don't want films which carry theatrical rights, for we pay no royalties and we charge none. Either 35 or 16 mm. films are suitable, silent or sound; preferably one, or, at most, two-reel subjects; and, if silent, they should be properly captioned. We should like to get at least five or even more clean, unused prints of each subject.

Now, ladies and gentlemen, girls and boys of Canada, I have finished my story of the Imperial Institute. I hope that you will all remember this Institute and wish us well in our work. Remember that we exist for the service of Canadians, as indeed of all fellow-citizens of the Empire. And, when any of you come to London, do please visit the Imperial Institute and give me a chance of showing you how we try to carry on there our responsibilities to your great and wonderful Dominion. We shall invite your criticisms and do our best to merit your support and your goodwill.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Indian, and Colonial Governments

THE QUALITY OF CASCARA BARK FROM KENYA

In a previous issue of this Bulletin (1936, 34, 424) a report was published on a sample of cascara bark grown by a planter at Njoro, Kenya Colony. The bark furnished a satisfactory amount of extractive matter and it was regarded with favour by firms of merchants and manufacturing chemists in London. In view of the fact, however, that the only satisfactory test for this material is a physiological one, arrangements were made for a further supply of the bark to be sent over for trial. As mentioned in the published report, two sacks of bark were received in August 1937. It was subsequently learnt that this new supply had been cut early in 1936 and had therefore been already stored sufficiently long to meet the requirements in that respect of the British Pharmacopoeia.

The material received at the Imperial Institute consisted of quills of very thin bark (up to 1 mm. in thickness), varying from 6 to 19 cm. in length and from 0·7 to 2·5 cm. in width. They were mostly 12 to 14 cm. long and about 2 cm. wide. Externally the quills were mostly reddish-brown and internally they varied from reddish-brown to nearly black.

The bark was examined with the following results, which are shown in comparison with those obtained with the sample previously received.

	Present sample. *Per cent.*	Previous sample. *Per cent.*
Moisture	8·6	8·5
Ash (expressed on the bark dried at 100° C.) . .	6·9	7·1
Aqueous extract (expressed on the air-dried bark as received	23·3	26·6

These results show that, like the earlier sample, the present material gave a satisfactory percentage of water-soluble extractive matter, but that as in the previous case the amount of ash was rather greater than the maximum (6 per cent.) permitted under the British Pharmacopoeia.

The firm of manufacturing druggists who had examined the earlier sample kindly offered to prepare a liquid extract from the new bulk sample and arranged for clinical trials at two hospitals in London. In each case they furnished at the same time an equivalent quantity of a liquid extract made in accordance with the British Pharmacopoeia from North American cascara bark, so that the two extracts could be tested side by side.

At one of the hospitals about twenty-five patients were concerned in the trials, and the manufacturing druggists have summarised the results as follows :

" The report from the hospital seems to indicate that the liquid extract made from the Kenya bark is therapeutically active and that there is little to choose between it and the extract made from the North American bark. Surgical cases appear to respond somewhat differently from medical cases, and men somewhat differently from women. It seems evident that whether the liquid extract is made from Kenya bark or from North American bark there is an ' individual ' dose, but this the prescriber has to find out for himself."

At the second hospital a similar number of patients received treatment with the two extracts in alternate weeks, and whilst it was reported that in every instance they preferred the Kenya preparation, as being less drastic, it was found to be quite efficient. The following observations on the results have been received from the hospital authorities :

" We feel that the relative strength in terms of efficiency as a laxative is that 2 drachms of the extract made from the Kenya bark is equivalent to 1½ drachms of the British Pharmacopoeia extract. Apart from efficiency, however, a considerable number of patients thought that with equal efficiency the Kenya extract caused less griping than the British Pharmacopoeia extract. These expressions of opinion were rather vague, so I would not put much stress on them, but there seems to be little doubt of the unanimity with which the patients described the British Pharmacopoeia extract as more drastic than the Kenya extract. If you told me that the British Pharmacopoeia extract contained a higher proportion of active principles than the Kenya extract, I think this might explain the difference we have found."

In view of these results it would appear that there should be no difficulty in disposing of commercial shipments of Kenya bark of suitable age and of similar quality to the sample now in question.

It is understood that one or two Kenya planters are already exporting cascara bark with satisfactory results, and it is hoped that the foundations have been laid for another addition to the list of new industries established in the Colony.

DANIELLIA OLIVERI RESIN FROM UGANDA

THE three samples which are the subject of this report were forwarded to the Imperial Institute by the Conservator of Forests, Uganda, in November 1937. The materials were stated to represent three grades of the resin of *Daniellia oliveri* (" African copaiba gum ") collected in the West Nile District. It was desired to ascertain whether the resin was suitable for export, and failing this, whether such material would be suitable for local use as a cheap end-paint for timber during air seasoning and shipment.

The samples were as follows :

Sample A. " Selected."—This consisted of fragments of resin varying in size from that of a small pea upwards, and lumps measuring up to 1½ in. × 1¼ in. × 1 in. There was also a small amount in a powdered condition. The pieces were covered with a white oxidised crust. The resin was friable and brittle, pieces being easily broken between the fingers, exposing a vitreous fracture. The colour of the pieces internally varied from pale yellow to rather dark amber, the paler pieces being in the majority. The sample was in good clean condition.

Sample B. " Seconds."—This consisted mainly of pieces of resin varying in size from about that of a small pea upwards. A few larger pieces were present, some measuring as much as 6 in. × 6 in. × 4 in., and these and the smaller pieces were mostly in the form of resinous conglomerates. A considerable proportion of the sample, however, was in a powdered condition. Some of the conglomerates were rather soft and sticky internally, and the sample contained a considerable amount of vegetable debris. The material was generally much darker in colour than that of Sample A, being mostly dark yellowish-brown internally. The sample had a dirty and unattractive appearance, and it was only on breaking the pieces that their resinous nature became apparent.

Sample C. " Unsorted."—This material generally resembled Sample B, except that it contained some fragments and lumps of resin similar to those forming Sample A.

Results of Examination

Representative portions of each sample were ground and examined with the following results :

	Sample A.	Sample B.	Sample C.
Moisture, etc. (loss at 105° C.) . *per cent.*	1·4	4·6	3·0
Dirt (matter insoluble in a mixture of alcohol 33 per cent. and benzene 67 per cent. by volume) . *per cent.*	3·4	23·3	14·8
Ash . . . . . . *per cent.*	0·4	3·2	3·4
Determined on dirt-free resin :			
Acid value	87·9	88·4	89·1
Ester value	17·7	30·2	24·9

Sample A was further examined as follows :

Solubility.—The resin was almost entirely soluble in alcohol-benzene mixture, and in a mixture of butyl acetate 50 per cent., alcohol 15 per cent., and toluene 35 per cent. ; slightly less soluble in oil of turpentine and butyl acetate ; partially soluble in benzene, chloroform, and linseed oil ; and only slightly soluble in acetone, amyl alcohol, ethyl alcohol, ether, and light petroleum.

Melting Point.—Employing the capillary tube method, the resin softened at 76-78° C. At about 99° C. the resin commenced to swell up and froth, and this frothing persisted until a temperature of 150° C. was reached, when molten resin commenced to collect at the bottom of the tube.

Varnish Trials.—A varnish was made up with equal weights of the resin and oil of turpentine, and filtered whilst warm. On cooling and applying to sized wood, the varnish dried in 24 hours, furnishing a pale, glossy coat which, however, was rather easily scratched. By incorporating linseed oil with the varnish a tougher coat was obtained, though this was only slightly less easily scratched than that containing no linseed oil.

Commercial Value

The materials were submitted to (*a*) a firm of brokers, and (*b*) and (*c*) two firms of merchants in London, through their representatives on the Imperial Institute Consultative Committee on Gums and Resins. These firms reported respectively as follows :

(*a*) " We cannot find any outlet for the two poorer grades of this resin and we doubt whether they have any marketable value. As regards the best grade (' Selected '), there may be a value in the neighbourhood of 30*s.* to 40*s.* per cwt. We do not, however, hold out too much hope of building up a big business in this grade ; a small business might be possible from time to time."

(*b*) " Neither the natural resin nor the second quality would seem to have any commercial value on this market, as the impurities contained therein are so great that I do not think any firm would be interested in the article. The ' Selected ' resin, however, would seem to have commercial possibilities. It is soluble in turpentine and has the appearance of a dammar. Its current value should be about £40 to £50 per ton."

This firm suggested that a trial shipment of a few cwts. of the ' Selected ' grade should be forwarded to test the market, and offered to assist in disposing of it. They pointed out, however, that this would only be worth while if there was a prospect of the material becoming available in commercial quantities.

(*c*) This firm considered that the insolubility of the resin in alcohol alone and in hydrocarbon solvents alone, and also its high acid value, were disadvantageous to its use in industry. The material appeared to be intermediate between dammar and resins of the Manila copal type, and they could not see much commercial prospect for it. They added, however, that it might be worth while to test its utility after esterification with glycerol or by incorporating it with certain synthetic resins.

Remarks

The results of the present investigation show that in its properties this *Daniellia oliveri* resin bears more resemblance to dammar than to any other commercial resin. It possesses a similar hardness to dammar and melts at about the same temperature. Dammar resins, although inferior in hardness and durability to the copals, are, owing to their pale colour and fairly good solubility both in oil of turpentine and alcohol, of special value in the manufacture of the so-called spirit varnishes, used largely for the varnishing of certain materials such as wallpapers and for indoor decorative work. The ready solubility of dammar resins also renders them useful in the preparation of cellulose lacquers.

The present resin, although fairly soluble in oil of turpentine, differed however from dammar in being only slightly soluble in alcohol. Its hardness, moreover, being inferior to that of copal resins, would still further limit its usefulness as a varnish resin. It seems possible that further investigations in certain directions may show that it has properties—not at present apparent—which would render it of value to the trade. One of the firms consulted, it will be noted, suggested that the material might furnish a useful product on esterification. Experiments at the Imperial Institute showed, moreover, that the resin, although insoluble (or nearly so) in alcohol, dissolved in mixtures of organic solvents such as are employed in the preparation of cellulose nitrate lacquers. The resin might therefore possibly be employed as a substitute for dammar in this connection.

In any case, however, only the clean selected resin, as represented by Sample A, would find a market in the United Kingdom. If such resin were offered on the market in the first instance at a comparatively low price, with a view to arousing the interest of the trade and encouraging industrial investigation, a satisfactory market for the material might eventually be established, assuming that sufficient quantities were obtainable for regular export.

With regard to the inquiry as to whether the resin would be suitable for use locally as an end-paint on timber during seasoning and shipping, it is considered that the material would probably prove quite satisfactory for this purpose. The low-grade unmarketable portions could be utilised in this way by treating them with oil of turpentine, and straining the solution from insoluble impurities.

PERILLA SEED FROM BURMA

PERILLA seed (*Perilla ocymoides*) yields a " drying " oil which is used in the manufacture of paint, varnish, printing ink, and linoleum, and in the countries of production also for edible purposes. At the present time commercial supplies of the seed are grown mainly in Manchukuo, with smaller quantities in China and Japan. The seed does not come to the United Kingdom, but a small amount is occasionally crushed in the United States. The oil itself, however, which is principally produced in Japan from imported seed, finds a considerable market in the United States and to a comparatively small extent in the United Kingdom. In 1936 as much as 52,635 tons of perilla seed oil were imported into the United States, about two-thirds coming from Japan and most of the remainder from Kwantung, but in 1937 the total imports had fallen to 19,460 tons. The quantity of oil shipped from Japan to the United Kingdom in recent years amounted to about 70 tons.

The production of the seed has been given consideration from time to time in various parts of the Empire, and reports on samples of seed received at the Imperial Institute from Cyprus, the Union of South Africa, Southern Rhodesia, India, and Hong Kong will be found in this BULLETIN, 1920, **18**, 479; 1926, **24**, 205. Although the results of these investigations showed that the oil obtained from the different samples of seed was of satisfactory quality, so far, apparently, no commercial developments have taken place.

In December 1937 a further sample of perilla seed, this time from Hsipaw State, Burma, was forwarded by the local Agricultural Officer for investigation. The seeds were of normal appearance, greyish-brown or orange-brown in colour and in good clean condition. The seeds as received were found on examination to contain 4·5 per cent. of moisture and to yield on extraction with light petroleum 44·7 per cent. of oil, equivalent to a yield of 46·8 per cent. expressed on moisture-free seeds.

The oil as extracted with light petroleum was of golden-yellow colour and deposited a very slight amount of stearine on standing. On examination it gave the following results, which are shown in comparison with the requirements of the British and American Standard Specifications for perilla oil:

	Present Sample.	Requirements of the British Standard Specification.	Requirements of the American Standard Specification.
Specific gravity at 15·5/15·5° C.	0·9336	0·932—0·936	0·932 (min.)
Refractive index at 20° C.	1·4816	1·481—1·484	—
Acid value	1·7	not more than 6·0*	5·0 (max.)
Saponification value	191·3	not lower than 189	190 (min.)
Iodine value (Wijs, 1 hr.) *per cent.*	193·4	not lower than 193	191 (min.)**
Unsaponifiable matter *per cent.*	1·0	not more than 1·5	1·5 (max.)
Colour	—	As agreed between purchaser and vendor	Not darker than a freshly-prepared solution of 1·0 g. potassium dichromate in 100 cc. pure sulphuric acid (sp. gr. 1·84).

* *Unless otherwise agreed between purchaser and vendor.*
** *Hanus method.*

The foregoing results show that the present sample contained a very satisfactory percentage of oil (the usual oil content of perilla seed being from 35 to 45 per cent.), and that the oil was of satisfactory quality and fulfilled the requirements of the British and American Standard Specifications.

In view of the fact, already mentioned, that there is no demand in the United Kingdom for the seed, it will probably be found advisable to crush Burma-grown seed locally, or in India, and to ship the oil to western countries. Consignments of oil of satisfactory quality from Burma should realise the current price, which in London is now £27 10*s*. per ton in bulk, spot, duty paid (November 1938). Burmese oil would enjoy the benefit of the preferential tariff and would be exempt from duty in the United Kingdom. The corresponding current price for the oil in New York is 9-9½ cents per lb.

KAPOK SEED FROM BRITISH HONDURAS

THE seed of the kapok tree (*Ceiba pentandra = Eriodendron anfractuosum*), which is so largely grown in the Dutch East Indies for its floss, is valued as a source of oil, and large quantities of the seed are shipped to the United Kingdom from Java for crushing. In view of the fact that the species is considered to be indigenous in Central America, the Conservator of Forests in British Honduras sent over to the Royal Botanic Gardens, Kew, a sample of locally grown seed in order to ascertain its quality in comparison with seed from other sources. The seed was forwarded to the Imperial Institute by the Economic Botanist, Kew, in July 1938 for investigation.

The sample consisted of seed of the usual appearance of kapok seed, but a considerable proportion of the seeds contained shrivelled or discoloured kernels. The weight of 100 seeds was 6·0 grams.

The material was examined with the following results, to which are added the corresponding figures for samples of kapok seed from various Empire countries previously examined at the Imperial Institute and the usual range of oil yield recorded for this seed:

	Moisture.	Oil in seed as received.	Oil expressed on moisture-free seed.
	Per cent.	*Per cent.*	*Per cent.*
Present sample . . .	11·0	19·1	21·5
Seed received from:			
Travancore . . .	11·4	24·3	27·4
Malaya (1)	13·8	20·0	23·2
,, (2)	12·9	18·8	21·6
Gold Coast	13·2	24·7	28·4
Zanzibar	12·7	21·0	24·0
Normal range		22—25	

The oil as extracted from the seeds with light petroleum was a golden-yellow liquid, which on long standing deposited a very slight amount of stearine. Its colour when determined in a 1-in. cell on the Lovibond scale was 2·5 red units and 30·0 yellow units. It was found to have the following constants, which are shown in comparison with the corresponding results for the oils obtained from the Travancore, Gold Coast, and Zanzibar seeds mentioned above and the recorded range of figures for kapok-seed oil:

	Present Sample.	Oil from seeds from Travancore.	Gold Coast.	Zanzibar.	Recorded Range.*
Specific gravity at 15·5/15·5° C. .	0·9219	0·9217	0·9226	0·914	0·921—0·923
Acid value .	18·6	30·9	6·1	26·0	Variable
Saponification value . .	193·3	192·2	193·5	194·2	190—197
Iodine value *per cent.*	92·2 (Wijs, ½ hr.)	90·4 (Hübl, 17 hr.)	89·6 (Hübl, 17 hr.)	101·5 (Hübl, 17 hr.)	95—110 (Wijs)
Unsaponifiable matter *per cent.*	1·1	1·2	—	—	—
Refractive index	1·4704 (at 20° C.)	1·463 (at 40° C.)	— —	— —	1·4613—1·4639 (at 40° C.)
Solidifying point of fatty acids .	34·7° C.	29·8° C.	—	—	32°—38° C.

* *Bolton, "Fatty Foods,"* p. 249.

The residual meal left after the extraction of the oil from the present seed was light pinkish-grey. It was analysed with the following results, which are shown in comparison with those recorded for the residual meal of the Travancore kapok seed previously examined at the Imperial Institute and the recorded figures for commercial kapok-seed cake:

	Present Meal.		Meal from Travancore Seed.		Commercial Kapok-seed Cake.
	As prepared.	Calculated to contain 7 per cent. of fat.	As prepared.	Calculated to contain 7 per cent. of fat.	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture . .	14·2	13·2	13·8	12·9	13·8
Crude proteins .	32·2	30·0	32·7	30·6	26·2
Fat . . .	0·3	7·0	0·5	7·0	7·5
Carbohydrates, etc. (by difference) .	21·3	20·0	19·8	18·4	23·2
Crude fibre . .	24·8	23·1	26·8	25·1	23·2
Ash . . .	7·2	6·7	6·4	6·0	6·1
Nutrient ratio	1 : 0·7	1 : 1·2	1 : 0·6	1 : 1·1	1 : 1·5
Food units . .	103	113	103	112	107

The results of examination show that the present seed had a rather lower oil content than that which is usual in commercial consignments of kapok seed, but this defect may have been due only to the fact that a considerable proportion of the seeds were defective. The extracted oil had a satisfactory composition, although its iodine value was slightly below the normal minimum figure.

The residual meal was similar to that obtained from the Travancore seed previously examined at the Imperial Institute, but like the latter it contained slightly more protein than is usual in commercial kapok-seed cake.

WATER-LILY SEED FROM THE SUDAN

THE sample of water-lily seed which is the subject of this report was forwarded to the Imperial Institute by the Director of the Agricultural Research Service in June 1938. The seed was submitted as that of a species of *Nymphaea* occurring in large quantities in Equatoria Province. It was stated that the seed, in the form of flour, formed the only vegetable food of certain sections of the Dinka, and it was desired to ascertain its nutritive value.

The sample consisted of small, greyish-brown seeds, with which was mixed a certain amount of vegetable debris and mineral matter. The seeds, which were roughly ovoid in shape and slightly ribbed on the surface, measured about 1·5 mm. in length by 1 mm. in diameter. The weight of 100 seeds was 0·11 gram.

The impurities present in the sample were separated as far as possible by sieving, and only the clean seeds, which formed 85·4 per cent. of the weight of the entire sample, were examined. Material coarser than the seeds, which was almost entirely of vegetable origin, accounted for 2·6 per cent. and material finer than the seeds 12·0 per cent. of the weight of the sample. The seeds were analysed with the results given in the following table, which includes for comparison (*a*) figures recorded by Joachim and Pandittesekere for a sample of *Nymphaea nouchali* seed grown in Ceylon (where this latter seed is stated to be used in the remoter dry areas as a substitute for rice, which it resembles in composition) and (*b*) the results obtained with a sample of Sudan dura (*Sorghum vulgare*) from the Sudan examined at the Imperial Institute:

	Present Sample.	Seed of *Nymphaea nouchali*.*	Sudan Dura.**
	Per cent.	*Per cent.*	*Per cent.*
Moisture	11·0	12·1	8·5
Crude proteins	9·6	8·0	13·1
Fat	1·1	0·9	3·3
Carbohydrates (by difference)	65·2	77·8	72·4
Crude fibre	4·1	0·7	1·0
Ash	9·0	0·5	1·7
Nutrient ratio	1 : 7·1	1 : 10·0	1 : 6·1
Food units	92·0	100·0	113·3

* *Tropical Agriculturist* (*Ceylon*), 1938, **90**, 7.
** *This Bulletin*, 1913, **11**, 33.

Tests on the present sample for cyanogenetic glucosides and alkaloids gave negative results, but no similar tests on the Ceylon *Nymphaea* seed are recorded by the investigators quoted. It will be observed that the Ceylon seed, unlike the present sample, furnished a very low percentage of ash.

The results of the examination of this water-lily seed show it to be a farinaceous foodstuff containing a fair amount of protein and furnishing a rather high yield of ash. The product would not be saleable in the United Kingdom for human consumption as it possesses no outstanding quality which would commend its use for this purpose, but although the seed is not so rich in proteins as dura it appears quite suitable for consumption by natives locally and possibly also in neighbouring regions.

If offered in large commercial quantities the seed might perhaps find an outlet in the United Kingdom in the manufacture of feeding-stuffs for animals, but the price obtainable would be low.

ARTICLES

HIDES AND SKINS OF NIGERIA[1]

By H. Hay-Barclay, M.R.C.V.S.
Veterinary Officer, Nigeria

The Colony and Protectorate of Nigeria, with the Mandated Territory of the Cameroons, situated on the tropical West Coast of Africa, is more than three times the size of the British Isles, having an approximate area of 370,000 sq. miles with a population of nearly 20 million people. The whole country is tropical and the further north one travels the more arid the country becomes, until in the extreme north, about 800 miles from the coast, one approaches the borders of the Sahara.

The herds of cattle and the flocks of sheep and goats are mainly to be found in the Northern Provinces of Nigeria, although there are considerable numbers of sheep and goats and 200,000 cattle of the small humpless type in the Southern Provinces. It is impossible to give the actual population of cattle, sheep, and goats in Nigeria, as no accurate count has ever been made, but it is certainly far in excess of the official figures for 1937, which were about 3 million cattle, 5½ million goats, and nearly 2 million sheep. These figures were based on the amount of the tax money which is collected annually and are not even approximately correct. The excess is greater in the case of goats and sheep than cattle.

Cattle

The main cattle herds of Nigeria are owned by pastoral tribes, most of whom are nomadic, moving constantly in search of seasonal grazing and water. The cattle belonging to nomadic

[1] The substance of a talk given on October 11, 1938, in the series organised by the Colonial Empire Marketing Board at the Glasgow Empire Exhibition and printed with the kind permission of the Board.

tribes, such as the Fulani, are never housed, although those belonging to small farmers may be kept in sheds at night in order to conserve the manure. With the exception of the humpless cattle of the Southern Provinces, the cattle possess humps. Commercially, no distinction is made between the various types of Nigerian cattle, although there are actually quite a number of types.

Hides from Northern Nigeria, which borders the Sahara Desert, where exceedingly dry conditions prevail during most of the year, contain very little moisture and consequently give a very high yield of leather. The hair is short. Branding is only occasionally carried out by the owners, not for identification purposes, but as a supposed cure for certain diseases. This practice, however, is actively discouraged.

Although no distinction is made in the types of cattle, a distinction is made in the hides, depending on the methods of preparation. The principal classes are Northern Ordinary Hides, Northern Butcher Hides, Southern Ordinary Hides, and Southern Butcher Hides, and each is divided into Best, Second, Third, and Fourth selections, and again into suitable ranges in weight. Each class is sold separately.

The light weights, having a fine grain and good substance, are chiefly made into box sides and the heavier weights into sole leather.

Goats

Goat farming is carried on extensively in the North, where the animals are usually the property of the women-folk. Each woman may own from one nanny and her kid to a small herd of some twenty or thirty animals. Ranching is carried on in the more dry regions of the North, and on these ranches herds of goats numbering up to 500 or more are kept. It is these goats, to be found in every town or village, which make up the millions of goats scattered over the whole country.

In the dry season, after the harvest has been collected, the goats are allowed to roam at large in proximity to the villages, but during the rainy season, lasting from four to six months, when the crops are growing, the animals are kept under control, either tethered in the open or kept in huts and hand-fed.

With goats there is no long-distance seasonal movements such as is the case with cattle. This explains why it is possible to find that each of several distinct types is concentrated within roughly defined geographical limits.

The goat population of Nigeria can be divided roughly into four main types—Sokoto, Kano, Bornu, and Adamawa. They are all short haired. The skins of each type are kept separate and packed according to quality for export.

Of first importance is the skin of the red-haired Sokoto goat. The skins are equal to the best in the world, and being of a fine grain they produce coloured glacé kid of the highest standard. There is a supply of cross-breds of the red-haired goat, but the skins are not so good as the pure red variety.

Next in value is the brown-haired Kano goat, of which the supply of skins is much greater than any of the other three types. It is an excellent skin of fine grain and good substance, and is very suitable for the manufacture of high grade glacé kid in colours and black. The lower selections are used for good quality suede kid. There is also a small supply of cross-bred skins from the Kano goat which is of secondary quality.

The third type is the Bornu, which is much larger in size than any of the other types, and the hair varies widely in colour, from pure white to red and white and other combinations of colour. These skins have a poorer grain and pelt than the previous types, but serve a useful purpose in making an excellent quality suede. Moreover, they are suitable for a lower quality of black glacé kid.

The fourth type is the Adamawa goat, which is generally a small animal, varying widely in colour from black to brown, and the skin has been considered as inferior to the other three types. This reputation is probably due to lack of attention paid in the past to proper preparation in this outlying region. Under the scheme for improvement, together with the provision of better communications, energetic efforts are being made to bring the preparation up to the level of the other types.

Sheep

Sheep farming is carried on in much the same way as goats, except that large flocks are more common and are owned by pastoral tribes. These tribes may graze their sheep along with their cattle, or in the arid and less cultivated districts they may ranch them separately.

The hair sheep of Nigeria, there being no wooled sheep, can be divided roughly into three main types, Belted Sheep, Large White Sheep, and Small White Sheep, even although many variations of these types exist. The skins are packed for export according to selection and type.

The belted, also known as the Oudah sheep, are large animals with two distinct colours of hair sharply demarcated, the front half usually being brown or red, the other half white. These sheep are to be found in large numbers in the North, particularly in Sokoto and Bornu Provinces. They have a close, short-haired coat and the skins are used for making good quality glove leather.

The small white type of sheep is the most common, and is found in large numbers scattered throughout the whole of the Northern Provinces of Nigeria. It is known locally as the Fulani sheep, and is a smaller animal than the other two types, having a shorter and finer hair. The skins are of good quality and are used to produce grain and suede gloving leathers of satisfactory quality.

The third type is the large white sheep, mainly of Bornu Province, which grows to a large size, having a hairy coat which is longer and denser than those of the other two types. These sheep are frequently brought to other markets, especially in Southern Nigeria, to be fattened for food. Their skins are of less value than the previous types and are used for making suede glove leathers.

Markets

Scattered throughout the Northern Provinces are thousands of small towns and villages where weekly or sometimes bi-weekly markets are held. On each market day a number of animals are slaughtered for meat, the quantity varying from an odd beast or so in small markets to 30 or more goats and sheep in addition to a number of cattle at the more important markets. In the large towns as many as 500 goats and sheep and more than 50 cattle may be slaughtered at the daily or weekly markets. In addition, many animals are slaughtered in the country for consumption at family festivals.

Trade in Hides and Skins

During the first few years of the present century the value of untanned hides and skins exported from Nigeria amounted to only a few hundred pounds sterling. By 1910 the exports had reached £8,899, and in the next few years the trade rapidly increased until in 1914 £407,500 worth were shipped. After that the values fluctuated considerably, the peak year being 1919, with a value of £1,116,894, and the lowest 1921, with £262,844. For the past ten years the values have ranged from about £550,000 to £900,000 annually. The detailed exports for 1937 are shown in the following table:

Exports of Hides and Skins (Untanned), 1937

Destination.	Cattle Hides.		Goat Skins.		Sheep Skins.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	lb. (00).	£ (00).	*lb.* (00).	£ (00).	*lb.* (00).	£ (00).
United Kingdom	21,963	514	7,209	658	8,685	640
Germany	7,671	211	1,259	117	173	13
Belgium	1,020	26	1,291	96	—	—
Holland	10,328	276	736	55	—	—
France	31,412	973	6,913	670	238	20
Italy	2,122	60	—	—	—	—
Portugal	3,396	92	—	—	—	—
Czechoslovakia	3,922	115	4,361	440	—	—
Bulgaria	7,971	231	—	—	—	—
Greece	7,475	250	2	(*a*)	—	—
United States	618	15	25,161	2,384	7,471	551
Other Countries	3,605	122	4	(*a*)	5	(*a*)
Total	101,502	2,884	46,936	4,420	16,572	1,224

(*a*) *Under* £100

Preparation of Hides and Skins

Prior to 1927 the stock-breeders of Nigeria were inclined to regard the hides and skins of their cattle, sheep and goats, as products of no great commercial value. In consequence, they paid no particular attention to the proper treatment of what was to them an unimportant by-product of their farming. The method of flaying practiced by the butchers was bad, and the method of drying hides and skins by pegging them on the ground resulted in a large number of what would otherwise have been first-class products showing either "sun-blister" or other signs of putrefaction, rendering them of low value.

The world demand for leather during the War and after caused a great increase in trade, and undoubtedly this increased demand was responsible for an increase in quantity but also for a falling off in quality exported, as any hides and skins offered by the natives found a market no matter what the quality.

Matters were not improved by the methods of collection. The African traders, travelling continuously from market to market, buying the raw hides and skins direct from the butchers, accepted partially dried hides and skins, with the result that some putrefaction took place before complete drying was effected.

The loss which was taking place due to this unsatisfactory state of affairs attracted the attention of the British tanners, who had been specially impressed with the high intrinsic qualities of the Nigerian goat skins. The British Glacé Kid Tanners' Association and other interested bodies made repeated representations to the authorities concerned. As a result of this agitation, the Veterinary Department of Nigeria put into operation about 1927 a scheme designed to abolish primitive methods of flaying and drying.

It can be realised it was not a simple matter to apply regulations for the widespread distribution of small markets of a conservative people. At the important centres, such as Kano, Zaria, Sokoto, and other places where large numbers of animals are slaughtered daily, it was comparatively easy to arrange supervision by African Inspectors and to enforce the provisions of the Hides and Skins Ordinance, but in the numerous small markets it was a very difficult problem to control effectively flaying and drying.

Flaying.—The first matter for consideration was bad flaying. Much of the damage is due to the African method of using sharp-pointed knives. The flaying with this type of knife is now actively discouraged, and in its place the use of a knife with a curved blade, which can be made by the local blacksmiths, is urged. With goats and sheep the knife is used only for the initial incisions, the process of flaying being completed by drawing off by hand. European Officers and African Inspectors of the Veterinary Department are continually instructing butchers in the correct method of flaying and trimming hides and skins. As soon as they become proficient it is obligatory for them to flay properly by the Regulations made under the Native Authority Ordinance.

Drying.—The second problem with which the Nigerian Authorities were faced in their scheme for improvement was to find the best method to introduce to dry hides and skins. All the hides and skins exported from Nigerian are dried. No salt is used because it is expensive, having to be imported from Europe and then transported long distances inland. Attempts have been made to export hides in a wet-salted condition, but this was not successful, chiefly on account of the heavy freight charges.

At the time the authorities took up the matter, i.e. about 1927, it had not been demonstrated that what was generally known to tanners as " sun-blister " was actually caused by putrefaction set up when hides and skins were pegged out on the ground to dry, or when they were bundled up before drying was completed. As a result of experiments on hides undertaken in Kenya in 1932 on the lines proposed by the Imperial Institute Advisory Committee in conjunction with the United Tanners' Federation, it was demonstrated that hides prepared by shade-drying with a free circulation of air on both sides were free from putrefactive changes, and that hides prepared by drying by the native method of pegging them on the ground in the sun or shade were badly blistered, but the result of outstanding significance was that hides dried in the full force of the sun, but raised a short distance from the ground, were practically free from " blister " or " taint."[1]

On a basis of these results the Committee recommended the " suspension " method of drying in hot climates where shade drying was not always practicable. An outcome of the Committee's report was a further series of trials on similar lines, conducted by the Government of Southern Rhodesia in 1934, in which the " suspension " method advocated by the Committee was fully tested.[2] The methods of drying which yielded the best results from the series of experiments were shade drying and sun drying by suspension. There was no material difference in quality by these two methods than from dry-salting. Experiments, especially on goat skins, have also been carried out in Nigeria which have confirmed the East African findings.

If putrefaction—which commences within a few hours in the tropics after removal of the skin from the carcass—is to be prevented, it is of the utmost importance that the drying is commenced as soon as possible, within 4 or 5 hours of flaying, and continued without interruption until the process is completed. The fact that putrefaction cannot always be easily detected in dried hides and skins before they are soaked at the commencement of tannery operations makes it all the more imperative to ensure that effective measures for the proper treatment are in force at the actual place of slaughter. Subsequent arsenication does not check this putrefaction, which continues until the final drying has taken place.

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[1] This BULLETIN, 1934, **32,** 41-109.

[2] *Ibid.*, 1936, **34,** 15-32.

As each market was brought under the Government scheme, the Native Administrations erected a drying shed in which the hides and skins are hung as soon after flaying as possible. Since shade drying produces excellent results, it is to be preferred, especially for sheep and goat skins, but the cost of erecting and maintaining thousands of these sheds is considerable, even although many are merely thatched roofs supported by upright poles.

As a result of the experiments instigated by the Imperial Institute proving that the sun's rays actually do very little, if any, harm to hides or even to the more delicate skins of goats and sheep so long as the hides and skins are suspended more or less vertically during the drying process with a free circulation of air on both sides, the question of shade has become a relatively unimportant matter. However, at all the markets in Nigeria where permanent drying sheds have been erected, shade drying will be continued. In drying sheds the hides and skins are usually suspended vertically from horizontal poles or wires, and the sides and lower edges are tied to the framework to prevent excessive crumpling. The practice of hanging them over poles is being discouraged, because improper drying takes place along the back on the line resting on the pole.

On the other hand, at many of the small markets which have no permanent sheds, suspension drying on frames in the open is now being advocated, and has already been put into practice throughout part of the country, or else, in order to save timber where it is scarce, the hides and skins are suspended from horizontal poles with the lower edges tied to pegs driven into the ground, care being exercised that the hides and skins are kept clear of the ground and a free circulation of air on both sides is maintained.

Regulations are now in force at all the large markets and many of the small ones for shade-drying where sheds are available. New regulations, however, have been drawn up and are now awaiting Government sanction, which have been designed to make suspension drying either in a shed or in the open compulsory, and also to prevent the removal of hides and skins before they are thoroughly dry.

The Marking of Hides and Skins

At all prescribed markets a distinguishing mark is allocated. This mark is stencilled on the hides and skins with a local dye, and consists of a letter denoting the Province and a number denoting the particular market at which the hides and skins were prepared. By these marks it is possible to trace any faulty flaying or drying. These marks, however, are for local information only, and provide no guide to overseas buyers. It has been suggested that hides and skins of Nigerian origin should be specially marked so that buyers and tanners could easily identify them. To satisfy this request, a system of permanent punch marks is being introduced. The mark will probably consist of the letter " N " indicating Nigerian origin, because all hides and skins exported from Nigerian ports are not necessarily of Nigerian origin, and another letter signifying the particular Province. For example, goat skins from Sokoto Province would probably bear the mark " NS."

Collection and Marketing

The collection of the hides and skins is undertaken by African traders who are sent out by companies to travel through the country gathering supplies from the various markets. These supplies are bought at current market prices according to quality, and are transported by camel, donkey, pack-ox, or motor lorry to the main depots of the exporting companies.

Before being exported all hides and skins are arsenicated. This is carried out for the protection of the dried hides and skins from the ravages of the skin beetles, and is done by immersion in tanks containing a solution of sodium arsenite (0·25-0·3 per cent.) and then thoroughly dried. Hides flayed at some of the large centres are bought by the companies before they are dried and are arsenicated immediately and then frame dried; these are known as " wet butchers." This method thus saves two dryings, but, of course, can only be carried out where the slaughtering is done in the vicinity of the tank. The next step is to place the hides and skins into the many classes required by tanners; this work is carried out under the supervision of European experts. Each selection is packed separately in press-packed bales, bound with rope, and then the bales are marked and numbered. In the North they are then loaded into covered-in railway trucks and sent down to Lagos, the main port of shipment.

Local Leather Industry

There is a local industry in Nigeria carried on under primitive conditions producing tanned goatskin and sheepskin.[1] The materials used and the methods of tanning produce a leather which has the properties of resisting the acid atmosphere of large cities. This valuable asset makes the leather especially valuable for book-binding and high-class upholstery. The skins are chiefly exported undyed to manufacturers in Britain who specialise in dyeing and finishing the skins for the purpose.

During the War there was a great demand for locally tanned goat and ship skins, especially in the United States, and the value of the exports in 1917 amounted to £182,345. In more recent years the values have fluctuated between about £20,000 and £40,000. The exports of tanned goat and sheep skins in 1937 were as follows:

	Tanned Goat Skins.		Tanned Sheep Skins.	
Destination.	Quantity. *lb.*	Value. £	Quantity. *lb.*	Value. £
United Kingdom	84,185	12,608	22,860	3,363
France	—	—	4,131	413
Tripoli	—	—	13,591	2,039
Italian Possessions	23,855	3,447	—	—
United States	6,408	641	—	—
Total	114,448	16,696	40,582	5,815

There is also a small export of locally tanned cattle hides which go to neighbouring Colonies.

Improvement of Stock

Considerable attention has and is being paid by the Veterinary Department in combating and preventing animal diseases. This work closely concerns hides and skins, but it is too big a subject to be gone into here. A brief account of investigations into the skin diseases of goats in relation to the quality of the skin will be found in "The Preparation of Hides and Skins," p. 102 (Imperial Institute, 1937).

Formerly no particular attention was paid by the African owners to the development of their herds, with the result that inferior types have shown a tendency to predominate in certain cases. An outstanding example has occurred in the Sokoto Province with the valuable red goats. During the last few years it has become evident that the number of pure red-haired goats in proportion to cross-breds was decreasing, due largely to the strong demand for the fine red goatskins. This fact has led to the introduction of a large-scale breeding scheme by the Veterinary Department in the Sokoto Province, with the result that the red goat population is now increasing. At the same time a reduction in the inferior cross-breds is taking place, due to an intensive campaign of castrating the inferior and undesirable male goats by trained Africans. In 1937 over 57,000 undesirable males were sterilised in Sokoto Province alone. This work is being carried on in other Provinces as well, and is not only confined to goats. By this means undesirable types are gradually being eliminated.

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[1] See "Tanning and Dyeing of Goat Skins: Native Method, Kano, Northern Nigeria," by W. G. Beaton, this BULLETIN, 1933, **31**, 56-59.

Conclusion

It is only by the measures outlined in the foregoing pages that overseas buyers can be protected against loss caused by damaged raw products. Although there can be no guarantee of quality on the part of the Nigerian Government, this scheme for improvement, supported by legislation, ensures the best preparatory treatment and freedom from unnecessary damage. Evidence of the marked success of this campaign is now to be found in the present high quality of the Nigerian products and the steadily increasing demands.

There is, however, one matter which requires stressing, and that is, in order to maintain progress, it is essential to obtain the full co-operation of all producers of hides and skins. This can only be secured by the knowledge that their extra labour in employing careful methods of preparation will prove remunerative. For this purpose a sound system of paying the actual producer a price strictly in accordance with quality is desirable.

TANGANYIKA

MINING ACTIVITY IN 1937

THE chief minerals produced in Tanganyika Territory are, in order of decreasing value, gold, salt, tin, and mica, with subordinate amounts of diamonds, building stones, tungsten, lead, phosphates, and red ochre. During recent years the annual value of mineral products exported or sold locally has increased steadily to £652,442 in 1937 ; the total value of such products for the 12-year period 1926-1937 was £3,471,256, equivalent to an average annual value of £289,271.

The following account of the mining developments in 1937 has been compiled from the recently published Annual Report of the Mines Division of the Tanganyika Territory Department of Lands and Mines.

Value of Mineral Products exported or sold locally

Product	1937.	1936.	1926-1937.
	£	£	£
Gold (with silver content)	526,338	490,490	2,292,782
Salt	52,667	47,569	430,925
Tin ore	49,488	41,784	197,160
Mica (sheet)	13,441	4,958	117,717
,, (waste, ground)	640	230	1,320
Diamonds	5,071	6,252	389,927
Building stones	2,834	2,569	33,238
Tungsten ore	855	267	1,679
Lead ore	578	—	578
Phosphates	310	150	1,948
Red ochre	220	59	2,160
Miscellaneous	—	—	1,822
Total	£652,442	£594,328	£3,471,256

In the above table gold is valued at the gross price realised; the bullion, with the exception of that from one mine which was sold in Johannesburg, was sent to London. Tin is valued at the gross price realised at the smelters; most of the ore went to Singapore, the remainder to Great Britain and the Netherlands. The diamonds were sent to Johannesburg, where they were valued by the Territory's official valuer. Salt is valued at the price realised at the works in Tanganyika. Mica is valued in accordance with sales returns, or, in the case of parcels unsold, is estimated. Building stones include only those quarried in or near a township, and the value is based on the average price at the quarry; the price obtained at destination was approximately £6,025 for the year 1937.

During 1937 there were 39 companies engaged in mining and prospecting operations in the Territory, 12 of which had their registered offices in the country. A total of 884 prospecting rights was issued during the year, the nationalities represented being as follows: British, 528; German, 136; Greek, 85; Italian, 15; French, 15; Belgian, 1; Other, 104. Twenty of these prospecting rights were endorsed with authority to prospect for diamonds.

The total area held in the Territory in connection with each mineral on December 31, 1936 and 1937, is shown in the following table:

Mining Areas in Tanganyika

	Leases				Claims				Exclusive Prospecting Licences				Special Exclusive Prospecting Licences			
	1936		1937		1936		1937		1936		1937		1936		1937	
	No	Acres	No	Acres	No	Acres	No	Acres	No	Sq m	No	Sq m	No	Sq m	No	Sq m
Gold (reef) . .	14	71,829	15	74,417	1,021	22,973	798	15,960	130	327	67	169	10	1,550	5	439
,, (alluvial) . . .	4	1,135	—	—	225	155	171	118	3	6	3	3	—	—	—	—
,, (reef and alluvial) .	1	48	1	48	—	—	—	—	1	2	2	4	—	—	—	—
Tin . . .	1	170	1	170	221	8,840	264	10,560	1	4	—	—	—	—	—	—
Tungsten .	—	—	—	—	—	—	17	680	—	—	—	—	—	—	—	—
Diamond .	8	144	4	74	37	740	38	760	3	7	1	1	—	—	—	—
Gold and Diamond . .	—	—	—	—	—	—	—	—	1	8	—	—	—	—	—	—
Salt . . .	5	535	5	572	26	920	13	520	—	—	—	—	—	—	—	—
Mica	—	—	—	—	99	49,500	105	52,500	—	—	—	—	1	367	1	113
Coal	—	—	—	—	40	1,600	17	680	1	8	1	8	—	—	—	—
Phosphates . .	—	—	—	—	6	240	5	200	—	—	—	—	—	—	—	—
Red Ochre . . .	1	20	1	20	—	—	1	40	—	—	—	—	—	—	—	—
Building Stones . .	2	19	5	42	41	1,640	56	2,240	1	1	1	1	—	—	—	—
Total .	36	73,900	32	75,343	1,716	86,608	1,485	84,258	141	363	75	186	11	1,917	6	552

GOLD

The total weight of bullion exported in 1937 was 93,110 oz. containing 74,676 oz. of fine gold and 10,595 oz. of silver. The gold content realised £525,394 (an average of Shs. 140/71 a fine oz.), while the silver content realised £944 (an average of Shs. 1/78 an oz.). Production from the various districts was as follows :

Province.	District.	Alluvial.		Lode.			Recovery.
		Bullion (oz.)	Fine Gold (oz.)	Crushed (*Long tons*)	Bullion (oz.)	Fine Gold (oz.)	*Dwts. per ton.*
Lake .	Mwanza	—	—	656	314	275	8·38
	Musoma	—	—	43,455	26,690	19,312	8·89
Western .	Kigoma	193	161	—	—	—	—
Central .	Singida	22	18	22,247	12,901	10,111	9·09
	Dodoma	30	25	—	—	—	—
S. Highlands	Mbeya	39,149	34,305	36,257	14,510	10,947	6·04
Eastern .	Morogoro	133	124	—	—	—	—
	Total	39,527	34,633	102,615	54,415	40,645	7·92

Twelve mines each produced in the neighbourhood of, or more than, 1,000 oz. of unrefined bullion during the year, and together accounted for 87 per cent. of the total reef production. Details are as follows :

Mine and/or Owner.	Crushed. (*long tons*)	Bullion. (*oz.*)	Fine Gold. (*oz.*)	Recovery. (*dwts. per ton*)
Musoma District				
Buhemba (South Nyanza Development Company and Mr. V. Koren) .	10,231	7,911	5,708	11·16
Mara (Tanganyika Diamond and Gold Development Company, Ltd.)	13,454	7,766	4,826	7·17
Ikungu (Major A. Russell)	4,299	3,391	2,908	13·53
Mrangi (Messrs. R. and F. Napier Clark) . .	1,089	2,800	2,527	46·43
Kiabakari (Major The Hon. G. L. O. Grundy)	6,161	1,349	1,048	3·40
Simba Sirori (Mr. N. Chand) . . .	3,153	1,130	834	5·29
Singida District				
Sekenke (Tanganyika Central Gold Mines, Ltd.) .	21,200	12,541	9,805	9·25
Mbeya District				
Ntumbi (Messrs. MacHugh and Davis) . .	7,336	3,716	3,146	8·58
Rukwa (Mr. T. H. Bayldon)	5,097	2,487	1,885	7·40
Menzies Reef (Tanganyika Minerals, Ltd.) . .	5,830	2,252	1,637	5·62
Safari Mines . . .	2,522	979	589	4·67
Mr. W. Martinaglia .	3,585	933	645	3·60

Lake Province

Mwanza District.—Geita Mine, owned by the Geita Gold Mining Company, Ltd., has been developed down to the main adit horizon giving about 600 ft. of "backs." The ore reserves on December 31, 1937, were 601,992 long tons averaging 4·34 dwts. a ton. A number of bulk tests of the ore were made with a pilot plant handling about 10 tons a day. The results confirmed that satisfactory extraction of the gold should be effected by fine grinding and straight cyanide treatment. Associated companies continued active development of other properties in the area, particularly Ridge 8 and Mawe Meru the option to purchase which mines were exercised during the year. Below the leached zone of the brecciated ore-body at Ridge 8 there is a zone of secondary enrichment of considerable tonnage. Mawe Meru is a smaller proposition but of high grade. There are also a number of other occurrences yet to be proved. It was decided to erect a central mill at Geita to treat ore from the Geita, Ridge 8, and Mawe Meru mines, the first unit to have a capacity of 250 tons a day. The ore from Ridge 8 is to be transported by aerial ropeway and the ore from Mawe Meru over a road constructed by the Geita Gold Mining Company, Ltd.

At the old Ngasamo Mine production was resumed on a small scale.

Kwimba District.—Much had been hoped for from a syndicate started under strong local auspices. It began by prospecting a large area but work is suspended. Prospects were located which deserve further work.

Musoma District.—Mr. V. Koran, the tributer working the Buhemba Mines of the South Nyanza Development Company, Ltd., is the largest producer in the district. He continued during 1937 to keep the mill supplied with high-grade ore and the plant was electrified with transmission from a central power-station. More money was spent underground and the mining methods improved.

The Tanganyika Diamond and Gold Development Company, Ltd., announced the sale of their Mara Mines to South and Central African Gold Mines, Ltd., controlled by the Anglo-Transvaal Consolidated Investment Company, Ltd.

The Ikungu Mine of Major A. Russell continued to show promise and was actively developed. Additional power and metallurgical plant were installed and at the close of the year a much-needed compressor was in course of erection.

At Mrangi Mine, Messrs. R. and F. N. Clark continued to treat high-grade ore. Some 1,700 oz. of bullion, representing about two-thirds of the total recovery, was obtained by hand-dollying about 7 tons of picked ore carrying visible gold. A larger mill was sent to the mine in the latter half of the year.

The Simba Sirori Minc, belonging to Mr. Nanak Chand, continued steady production throughout the year. In addition to the above a number of smaller scale mines were worked during the year.

The Eldoret Mining Syndicate, Ltd., abandoned their exclusive prospecting licences north of the Mara River. This throws open to other prospectors an auriferous area with possibilities.

Western Province

Kigoma District.—Uruwira Goldfields, Ltd., have proved a new field of considerable promise on the area held by them under special exclusive prospecting licence No. 112. The company are in process of proving alluvial gold which should enable ground sluicing to be carried on after water conservation schemes have been completed. The very extensive lode system so far mapped shows galena in the northern part of the area; in the centre, quartz reefs carrying gold with copper minerals are present; in the southern part there are also auriferous quartz reefs but they appear to carry less copper, and there are prospects of easily treated ore. This new field, which is called the Ukonongo goldfields, is the most important mineral discovery in the Territory since the value of the Saragura goldfield in the Mwanza district was made apparent. The field was located as the result of careful scientific prospecting for more than two years by a trained geologist, and indicates what big discoveries may yet be made in the Tanganyika Territory.

Kahama District.—A winze sunk from the adit level on the Jubilee Reef prospect reached a vertical depth below outcrop of 200 ft., but work has ceased.

Central Province

Singida District.—The equipment of the main shaft at the Sekenke Mine of Tanganyika Central Gold Mines, Ltd., had not been completed by the end of the year. There was unfortunate loss of parts of the new steel headgear in transit. The depth of the main shaft at the close of the year was 460 ft.

Southern Highlands Province

Mbeya District (*Reef*).—East African Goldfields, Ltd., transferred the mining lease covering Saza Mine to Saza Reefs (Tanganyika), Ltd. Plans for the mill were reduced to a small unit crushing about 100 tons a day and delivery of this plant was in progress at the close of the year. There are ample reserves for a plant of this capacity and development was suspended until it could be brought into operation. Shaft sinking had reached a vertical depth of 446 ft. at the time of suspension of development.

The syndicate known as Safari Mines continued to work a claim owned by Major B. F. Webb. Active development and production on a small scale was carried on throughout the year.

At the Ntumbi Mine, which was easily the biggest producer on the field, Messrs. MacHugh and Davis are successfully mining and treating two narrow reefs. Power is from wood producer gas, and cyanide plant was installed towards the end of the year.

Tanganyika Minerals, Ltd., confined their activities to the Menzies Reef. Development and production were suspended during the last quarter of the year and a start made on the erection of new power and treatment plant.

Mr. T. H. Bayldon continued steady production from the Rukwa " A " occurrence.

Development, and in some cases also production, was in progress on a number of mines in addition to the above, and it is interesting to note that at the close of the year there were 19 mills either in operation or under construction.

Mbeya District (*Alluvial*).—There was a conspicuous falling off in output during the year partly due to a large number of diggers leaving the field and to showers during the last quarter of the year interfering with dry-blowing but without providing enough water for sluicing or panning. There were further improvements in dry blowers, which retained their popularity, and a very small portable sluice-box, known locally as a " debe-box " was developed.

The finding of a nugget weighing 62·6 oz. was reported from the Makongolosi area.

African Minerals, Ltd., systematically trenched, pitted, and sampled alluvial deposits with a view to exploitation on a larger scale. During the latter half of the year dry-season production was commenced with a number of dry-blowers and arrangements were made for sluicing when sufficient water became available.

Eastern Province

Morogoro District.—A few persons continued to produce alluvial gold, on a very small scale, on the Ruvu River and its tributaries.

TIN

The total weight of tin ore exported during 1937 was 272 long tons, which contained 197 tons of metallic tin giving an average of 72·47 per cent. metal content. The price realised was £49,488, an average of £182 a ton of cassiterite concentrates or £251 a ton of tin. This is £49 a ton higher than the average price realised for 1936 exports.

Production of ore during the year amounted to 335 tons, an increase of 21·8 per cent. over the previous year. Of this production 6 tons were alluvial tin from the Busubi Chiefdom of the Biharamulo district, and the remainder, consisting mostly of detrital but with some lode tin, from the Karagwe tinfield, which is in the Bukoba district and in the extreme north-western corner of the Territory.

During the year the British Tin Smelting Company, Ltd., established an office at Kikagati on the Uganda bank of the Kagera River and announced their willingness to buy any quantity of tin ore, however small, for cash. This has been of considerable advantage to the small producers who previously had to save up their output until the parcel was worth exporting. This company now has a buying post at Murongo on the Tanganyika bank of the river which saves the producers from having to get export permits before selling to them.

TUNGSTEN

In 1937, 2·33 long tons of wolfram concentrates were exported realising £854 11*s*. 6*d*. The average tungstic acid content was 71·87 per cent. The average price realised was

Shs. 102/05 a unit, as compared with Shs. 33/80 for the previous year.

The material was obtained from a mine situated a few miles to the east of the Karagwe tinfield.

LEAD

The first consignment of lead ore to leave the Territory was despatched in December 1937. It consisted of 43 tons of galena concentrates and realised £577 14*s*. 6*d*. The ore contained 32 tons of metallic lead, equivalent to 74·5 per cent., which was valued at £471 8*s*. 4*d*. There was a silver content of 1,101·32 oz. troy for which £95 4*s*. 8*d*. was allowed, and a gold content of 3·355 oz. troy worth £19 18*s*. 5*d*. A penalty of £8 16*s*. 11*d*. was incurred by the presence of 0·43 cwt. of bismuth.

The ore was from the Mukwamba Reef of Uruwira Goldfields, Ltd., situated near the eastern border of the Kigoma district. The predominant valuable mineral in the lode is argentiferous galena, which occurs in massive formation and is also reported to occur disseminated in the quartz gangue. There are prospects of a considerable tonnage of ore, but the successful exploitation of the deposit, as of any base-metal ore, is dependent not only on a large tonnage, but also on cheap transport. The urgent need is the completion of the road, already commenced, to connect the mine at Mpanda with the railway at Uvinza. The distance from Mpanda to Uvinza is 140 miles compared with 210 miles from Mpanda to Tabora.

DIAMONDS

The number of diamonds exported was 3,575 and the total weight 3,234 carats, an average of 0·90 carats. They were valued at £5,071, an average of Shs. 31/36 a carat. These exports included 16 stones weighing 10 carats or over. The biggest weighed 20·25, 19·0, 16·0, and 14·75 carats, and were valued at £3, £66 10*s*., £8, and £368 15*s*. respectively.

The Tanganyika Diamond and Gold Development Company, Ltd., continued to produce at Kizumbi in the Shinyanga district and also recovered a few stones from a deposit near Misungwe in the Mwanza district.

SALT

The total non-native production of salt during the year amounted to 8,585 long tons. The amount sold was 9,348 tons as compared with 8,533 tons during the previous year; 2,340 tons having been brought forward from 1936; 40 tons written off as shortage on old stocks, and 1,537 tons carried forward at the end of the year. The value of the salt sold was £52,667, an average of Shs. 112/68 a ton as compared with Shs. 110/33 a ton in 1936.

The bulk of the production was by Nyanza Salt Mines (Tanganyika), Ltd., from a well at Uvinza in the Kigoma district and by coastal workers (selling through Tanganyika Salt, Ltd.) from the evaporation of sea-water.

MICA AND VERMICULITE

In 1937 exports of muscovite mica were 32·6 long tons of sheet valued at £13,441, and 40 long tons of ground-waste valued at £640, a total of £14,081. This is a very substantial increase over the 1936 total of £5,188. Some samples of sheet phlogopite and also of vermiculite were sent away.

Prospecting was carried on in the Bagamoyo and Handeni districts and some new areas were pegged in the Dodoma district. The production of muscovite was stimulated by the enhanced prices obtained, but restricted by shortage of labour in the Uluguru mountains. The Uluguru Mica Company, Ltd., the Territory's largest producer of sheet mica, installed additional compressors and extended the dry-weather road system. The ore reserves have been extended by underground development and there are now " backs " exceeding 200 ft. above some of the adits. The only other large-scale producer of sheet mica was Mr. T. Bain. A small quantity of mica was exported from the Sibwesa field in the Kigoma district. Practically all the ground waste was produced by Mr. R. Ruggles-Brise, from the Morogoro district.

From an occurrence of vermiculite discovered by Mr. T. Bain at Kwekivu in the Handeni district a very high grade product can be obtained.

The vermiculite should be exported sized but unexpanded. At a price in London or New York of about £6 a ton it is doubtful whether the mineral can be profitably exported, but in view of the excellent heat insulating properties of the expanded product it may be possible to develop a market within East Africa.

Phosphates

Production and sales during 1937 amounted to 102 long tons, which were sold for £310. The bulk of the production was by Mr. E. G. Sargant from deposits leached out of bat guano in limestone caves in the Mbeya district. Its qualities as a fertiliser are reported to be excellent, but even a reduction in price from Shs. 70/- to Shs. 45/- a ton failed appreciably to stimulate sales to the local agricultural industry.

Building Material

Returns submitted by the holders of claims and mining leases granted for building material show the total production during 1937 to have been as follows:

Province.	Stone (*Cu. ft.*)	Gravel (*Cu. ft.*)	Sand (*Cu. ft.*)	Clay (*Cu. ft.*)
Lake	40,868	6,334	44,995	—
Western	334	—	—	—
Central	3,313	—	414	—
Southern Highlands	13,020	—	—	—
Eastern	391,583	250,302	392,578	27,700
Southern	1,083	—	—	—
Northern	1,200	—	13,500	—
Tanga	—	—	13,836	—
Total	451,401	256,636	465,323	27,700

Red Ochre

During 1937, 50·71 tons of red ochre were sold for £220. The value of sales during the previous year was only £59. The mineral is used by natives as a cosmetic and the chief producers are Mr. J. P. le Grange, in the Arusha district, and Messrs. M. L. Kanji and M. Nanji in the Usambara (now Korogwe) district.

Coal

There are as yet no developed coalfields in Tanganyika. It is interesting to record, therefore, that a General Notice (No. 1043) was issued in the *Tanganyika Territory Gazette* for October 14, 1938, inviting companies to apply for licences to prospect for coal in a circular area within 40 miles radius of Mkata railway station.

EMPIRE SUPPLIES OF KYANITE

KYANITE, a natural silicate of alumina (Al_2SiO_5 or $Al_2O_3.SiO_2$), is finding a steadily growing market for the preparation of refractories. It is not used in the raw state but is first fired at 1,450 to 1,500° C. and then ground ready to mix with the bond. This preliminary firing completes a large volume change which would otherwise take place on burning and shatter the brick; it also converts the kyanite into a mixture of mullite and silica according to the equation:

$$\underset{\text{Kyanite}}{3(Al_2O_3.SiO_2)} = \underset{\text{Mullite}}{3Al_2O_3.2SiO_2} + SiO_2$$

The product of calcination, however, is known in the trade as "sillimanite," a misnomer which often leads to confusion. Sillimanite and andalusite are other natural minerals of exactly the same chemical composition as kyanite (but differing in physical properties) and both are likewise converted on heating into mullite and silica. The conversion of andalusite into mullite is not accompanied by any change in volume and this mineral can therefore be used in the raw state as a refractory. Up to cone 20 sillimanite may also be used in the natural state, but in order to produce a body of constant volume it would be necessary to fire it previously well above cone 20 (1,530° C.).

Of the three natural minerals, however, kyanite is much the most important commercially, and this is largely due to the fact that it occurs in really large and easily workable masses capable of affording a considerable and steady supply of material of uniform grade. Again, kyanite changes into mullite at the lowest temperature of the three and owing to the manner in which the resultant mullite crystals interlock it is believed that kyanite gives a stronger mechanical body than andalusite. In sillimanite and andalusite the mullite crystals develop parallel to the direction of the *c*-axis of the original crystal, but in kyanite the mullite needles grow inwards, perpendicular to the surface of the original grains.

Mullite made from kyanite is used in the construction of numerous types of furnaces, including electric furnaces and those for the enamelling and glass industries. When added to ceramic compositions containing clay and kaolin it is claimed to reduce shrinkage, lower the coefficient of expansion, increase breaking strength, resistance to abrasion and electrical resistance, and extend the sintering range. It is useful for the manufacture of kiln furniture, and balls for grinding mills can be made of it which are truly spherical as well as tough and hard. In the form of special plastic cements it can be used for setting, patching, and repairing furnace brick work. It is also a constituent of certain sparking-plug porcelains.

Kyanite is usually a rock-forming mineral and only rarely does it occur in large monomineralic masses as segregations in quartz-kyanite gneiss or schist. Attempts to separate kyanite from the other minerals of kyanite-bearing rocks must inevitably necessitate crushing and grinding ; but the manufacturer of refractory bricks requires coarse grog as the backbone of his shapes, so that the interstices can be filled with fine grog and then a plastic binder. Most of the American kyanites, which are separated from the minerals present in the rock either by a wet process or by magnetic separation, screening, and tabling, are converted on burning into weak and small grains which will not serve satisfactorily as grog, whereas the Indian kyanite, which is of the massive variety, affords a coarser grog and retains much of its strength after burning. Thus it is that Indian kyanite is the most popular at the present time, considerable quantities being imported into the United Kingdom where it is calcined and supplied in various grades and mixtures.

The production of kyanite in India commenced in 1924 and by the end of 1933 it had totalled 33,000 tons. Since that date, however, production has increased several fold and amounted to 24,787 tons in 1936. The production figure for 1937 is not yet available, but the exports from India in that year were 24,886 tons. Figures for the production and export of kyanite from India during the last ten years are as follows :

India—Production and Export of Kyanite
(Long tons)

	Production.	Exports.
1928 . . .	2,241	not available
1929 . . .	3,618	
1930 . . .	8,641	5,814
1931 . . .	3,412	3,991
1932 . . .	5,580	2,188
1933 . . .	4,283	5,646
1934 . . .	9,411	6,527
1935 . . .	19,903	15,337
1936 . . .	24,787	22,254
1937 . . .	not available	24,886

With the exception of small parcels from Ajmer-Merwara, Rajputana, and Mysore, the entire output comes from Singhbhum, in Bihar. Over 96 per cent. of it comes from Lapsa Hill in Kharsawan, where it is quarried by the Indian Copper Corporation, Ltd. J. A. Dunn (*Mem. Geol. Surv. India*, 1929, 52, 145-274) has shown in Singhbhum that kyanite rock, associated with quartz-kyanite rock, occurs at intervals along a belt of country nearly 70 miles in length. At Lapsa Buru there are enormous beds of kyanite-quartz rock containing segregations of massive kyanite. It is often of the radiating, columnar variety, and crystal blades of over 12 in. in length have been seen. The debris at the surface and to a depth of only one yard is estimated on a very conservative basis to contain 214,000 tons of kyanite, and the total may be ten times this amount.

Smaller quantities have been obtained from Ghagidih, about 2 miles south of Jamshedpur, also from kyanite-quartz rock. The mineral is collected from the surface deposits and 20,000 tons are believed to exist down to a depth of 1 yd. Smaller deposits are also located at Bakra (10,000 tons) and Kanyluka (8,000 tons).

Recent discoveries made in Nyasaland by the Geological Survey Department suggest that alternative supplies of kyanite may become available from that country. In dealing with the geology and mineral resources of the area west of the Nyasaland Railways northern extension, J. B. Alexander describes a large new deposit of kyanite between Dzonze Mountain and Kapiridimba on the Kirk Mountains plateau (*Annual Report of the Geological Survey Department* for the year 1937, pp. 22-24). This deposit is within 20 miles of the railway. Kyanite was recorded in the area north-west of Dzonze Mountain by the Imperial Institute Mineral Survey in 1906, and other occurrences on the Kirk plateau were described by the Geological Survey in its Annual Report for 1935, but the mineral has not previously been recognised in Nyasaland in quantities sufficiently concentrated for economic exploitation.

A series of massive kyanite segregations in kyanite-quartz-gneiss, occurring as lenticles in the Basement gneisses and schists, has been discovered on the main Kirk Mountains plateau at a point approximately 7 miles south of Nzama Mission by footpath and three-quarters of a mile south-south-east of Kapiridimba Peak. The main part of the deposit appears as two small hills, rising 125 ft. and 50 ft. respectively above the general level of the main west-east ridge. Boulders of kyanite-quartz-gneiss and massive kyanite-rock occur along the crest and upper slopes of these hills. Segregations of massive or coarsely crystalline kyanite range in size from a few inches in diameter up to masses weighing 30 tons. Ten of the larger boulders taken at random near the crest on the east side of the main hill were measured and estimated to weigh over 100 tons in all. Many such boulders have fallen down the hillslopes and may be found up to a distance of 200 yds. or more from the central ridge; moreover, the boulders are often grouped in clusters, which probably indicates that they are *in situ*, or nearly so, and represent outcrops.

It is estimated that there is a minimum debris-strewn area of 168,000 sq. yds., of which the central section of 53,000 sq. yds., calculating on an average of 1½ per cent. (90 lb. per cu. yd.) massive kyanite down to a depth of 1 yd., and allowing 10 cu. ft. of ore to the ton, will yield at least 2,000 tons of kyanite rock. Taking the northern and southern sections of 115,000 sq. yds. as yielding only ½ per cent. (30 lb. per cu. yd.) massive kyanite to a depth of 1 yd., a minimum of 1,500 tons may be expected. Half of the total of 3,500 tons of kyanite in this deposit occurs as boulders of massive kyanite-rock requiring only breaking to lumps of suitable size for transport, while the other half would require separation from low-grade matrix by hand-cobbing.

The debris has been found to be derived from a band of lenticular segregations of massive kyanite of varying sizes up to 5 ft. in diameter, occurring in bodies of kyanite-quartz-gneiss, which themselves occur in lenticular forms intercalative in variable quartzitic and micaceous gneisses and schists, over a strike length of three-quarters of a mile. The foliation has a dip of 40° to 70°. It appears to be a reasonable assumption, therefore, that a set of conditions similar to those on the surface prevails to a depth of at least 10 yds., but, taking only a third of the area as being productive to this depth, some 12,000 tons of kyanite should be available. It is probable, however, that the conditions described extend to greater depth, and on this basis the estimate could be correspondingly increased.

A 10 lb. sample from the main deposit was sent to the Imperial Institute for report. It consisted of coarsely-bladed, radiating, and columnar masses of kyanite, some of the pieces containing garnet, mica, staurolite, etc., and others iron staining. A representative portion of the sample was submitted to a partial chemical analysis at the Imperial Institute with the following results (A):

	A.	B.	C.
Alumina (Al_2O_3) . .	58·19	(61·9)	(65·52)
Silica (SiO_2) . .	36·71	(36·8)	(31·07)
Titania (TiO_2) . .	1·27	(0·6)	(1·43)
Ferric Oxide (Fe_2O_3) .	0·86	(0·9)	(1·50)
Lime (CaO) . .	n.d.	n.d.	(0·34)
Magnesia (MgO) . .	n.d.	n d.	(0·04)
Loss on ignition . .	2·58	2·2	
	99·61		99·90

NOTE.—*Figures within brackets were determined on ignited material.*

A portion of the sample was submitted to a firm engaged in the refractories trade who obtained the analysis B. This analysis is not strictly comparable with A owing to the fact that the figures within brackets were determined on the ignited material. C is claimed to be an average analysis of the calcined Indian material. It will be seen from this that the Indian material is rather more aluminous, but this is due to the presence of a little corundum (Al_2O_3), for the theoretical alumina content of kyanite is 63·2.

It is reported that the Nyasaland deposits have attracted the attention of a South African mining firm.

In addition to Nyasaland, there are deposits of kyanite in British East Africa which may perhaps be regarded as potential resources, though a commodity fetching about £5 a ton delivered at United Kingdom ports does not afford a commercial proposition unless transport and other charges are low and there is a sufficiently large and steady demand. Samples of kyanite of good quality from a deposit said to have been recently discovered in Kenya have been received at the Imperial Institute, and although details are not available, the producer, who has already sold a quantity of fine museum specimens, claims that he could make shipments at the rate of 100 tons a week, provided the demand and price obtainable were to warrant it.

Large quantities of kyanite have also been described by

A. D. Combe (*Geological Survey of Uganda, Memoir No.* II, pp. 39-40) from south of Lake Karenge, Ankole District, where the mineral is associated with quartz veins in mica-schist, and coarse-bladed monomineralic aggregates measuring 5 ft. in diameter are common. Individual crystals in these aggregates reach a maximum length of 18 in.

In Western Australia, kyanite is extremely abundant in the Chittering Valley, 40 miles from Perth, where it occurs as crystals from 0·1 to 2·5 in. in length in micaceous schists and gneisses. In various parts of this valley, according to Dr. E. S. Simpson (*The Minerals of Western Australia, Fourth Edn.*, 1935, p. 17), there are millions of tons of such rocks carrying 10 to 40 per cent. of kyanite, as well as occasional lenses of the pure mineral. Dr. Simpson is of the opinion that there should be no serious difficulty in obtaining a pure kyanite concentrate from such rocks, as water and fuel in this area are plentiful.

ACTIVE CARBON

THE value of active carbon, the industrial utility of which first became widely recognised during the Great War, has been greatly increased of late, not only by reason of its employment as one of the essential components of the war-gas respirator, but also by the rapid expansion of the rubber industry in which the substance is used for solvent recovery, and by its application to benzol recovery at gas works.

The fact that carbon in a certain form exhibits the property of extracting and temporarily retaining certain gases, vapours, and liquids has been common knowledge for generations past, and the conception of the respirator is no recent event. As long ago as 1854 Dr. Stenhouse devised what was probably the first effective respirator, the idea being initiated when he became aware of the fact that freshly prepared charcoal has the power of adsorbing the noxious odours arising in putrefaction. He invented a relatively simple mouth and nose mask containing a charcoal filter, the manufacture of which was entrusted to Ferguson and Sons, instrument makers to St. Bartholomew's Hospital. It consisted of a thin copper sheet, the rim of which was edged with lead and the interior padded with velvet, shaped to fit closely to within half an inch of the eyes and about an inch either side of the mouth. Inset into the copper sheet were two fine wire gauzes, $\frac{1}{8}$ to $\frac{1}{4}$ in. apart, with charcoal between. The respirator was held in position by a stout elastic band passing round the back of the head, and was designed " to absorb and destroy any miasmata or infectious particles present in the air in the case of fever and cholera hospitals, and of districts infected by ague, yellow fever, and similar diseases." Patents were granted on July 19, 1860, and May 21, 1867.

Dr. Stenhouse tested the respirator in concentrations of ammonia, sulphuretted hydrogen, and chlorine, and found it to function with a high degree of efficiency. To check corrosion of the copper he had it electro-plated with silver, though he recommended either platinum or gold plating in preference. The charcoal originally employed was prepared from bones, but wood charcoal was later found to be more effective.

The foresight of this medical man did not end here, for in addition to respirators, he suggested that " persons living in pestiliferous areas might make their houses as air-tight as possible " and admit air only through charcoal filters. It is a pity that so much valuable work should have been overlooked in the period of emergency which arose some sixty odd years later.

For a long time the applications of active carbon in the form of freshly burnt charcoal were practically limited to its use as a decolorising agent in such processes as sugar refining (the earliest use, dating from the fifteenth century), the purification of water, and the removal of stenches, and bone-charcoal was principally used for these purposes on account of its superiority both in mechanical strength and activity over any other form of charcoal formerly obtainable.

The growth of the demand for active carbon as a decoloriser, however, instigated research into the production of compact carbon with a high factor of activity. It was perceived that in the process of carbonisation tarry products are evolved which glaze the char-base and, by isolating it, greatly reduce the activity. As a consequence chemical methods were developed to remove these compounds without destroying the carbon, and among other substances, sodium chloride, calcium chloride, ferric chloride, sulphuric and phosphoric acids have been so used. The actual method employed usually consisted in impregnating or extracting the ground carbonaceous material with the oxidising chemical, carbonising it at a temperature between 500 and 1,100° C. and removing the oxidation products with dilute hydrochloric acid.

Active carbons have been prepared from most woods and vegetable residues, but coconut shells have so far proved to yield the best products, and are very extensively used, except in decolorising work in the sugar industry in which cheap bone-charcoal is almost universally employed.

The great demand for active carbon, however, may be said to have originated in 1916 when the Bayer company's patent describing a simple means of recovering adsorbed solvent from active carbon by means of steam was announced. The utility of the process particularly in the recovery of casing-head spirit and in town gas preparation was soon apparent, and supplies of suitable carbon were soon in considerable demand. Price considerations limited the full employment of the material, however, until the steam method of activation was developed in the United States and made active carbon generally available.

Broadly, the activation by superheated steam is best carried out between 700 and 950° C., and the quality of the carbon rises with the steam consumption but the yield is inversely affected. The steam exercises a dual action on the charcoal, both removing the oily hydrocarbons formed in the carbonisation process, and reacting with the carbon base and so promoting porosity. Excessive steam treatment results in extensive reduction in the quantity of carbon residuum and hence loss in total activity. The finished material has a black velvet-like appearance. Other gases such as air, carbon dioxide and chlorine may also be employed as activating agents, but control of the process and its efficiency are more difficult than with steam.

All processes aim at preparing a carbon of good strength and high activity; where the former cannot be achieved by direct carbonisation, the raw material is usually briquetted with a binder such as tar or pitch mixed with casein. Activity is commonly understood to be intimately associated with the capillary structure developed in the carbonisation process and theories have been advanced based on the ultimate structure of the carbon base being graphite molecules which form minute broken crystals.

Of late the extreme urgency of providing active carbon in large quantities in this country has led to the Fuel Research Station carrying out an investigation for the War Office into the suitability of British coals for the purpose, the report on which is now published (*D.S.I.R., Fuel Research, Tech. Pap. No.* 47, 1938). The preparation of active carbon from coal is not new, however, and a considerable amount of research had already been carried out both by the United States Bureau of Mines and by private enterprise in this country.

In the United States the work has hitherto been carried out on ground and briquetted coals, but to reduce costs the Fuel Research Station decided to attempt the carbonisation of lump coal carefully graded to the necessary size. The choice, therefore, was limited to seams carrying coals or bands of coal capable of yielding a dense, hard coke the micro-porosity of which could be magnified by a steam-activation process. Such coals exist in the " hard " durain bands which are a feature of certain seams in Northumberland, Nottinghamshire, Derbyshire, South Yorkshire and Warwickshire; in the splint coals of Fife; in the Scottish cannels; and in the South Wales non-coking coals of 15 to 18 per cent. volatile matter and bituminous types of 32 to 38 per cent. volatile matter. Of these coals the " hards " and " splints " proved most satisfactory.

Small-scale trials began on the Warwickshire Slate coal and then changed over to the durain band from the Top Hard seam at Sherwood Colliery, Nottinghamshire. The coal was graded between 1 in. and ⅜ in. screens and carbonised at temperatures between 480° and 700° C. in horizontal steel retorts designed for low temperature carbonisation work, the carbonisation time ranging from 12 to 8 hours. The resulting coke was activated in a Chronite retort, gas-heated and fed with steam. Results showed that the loss of activity owing to higher carbonisation temperature was negligible (700° as compared with 480° C.); that it is advantageous to activate relatively large pieces of coke to maintain a good friability value, and that a steam-air current yields no increase in activating value but increases friability. Of the coals examined individually, the Fifeshire durains from the Main of Kelty and Diamond seams gave the highest service time in an adsorption test using carbon tetrachloride, but trials with blends of strongly coking and non-coking coals (i.e. Parkgate seam of Yorkshire with the Sherwood " Hards " of Nottinghamshire) clearly indicated that higher activity and greater strength are obtained than with weakly coking coals.

Large-scale trials were performed on the Sherwood " Hard " seam after this success had been obtained, the coal being coked in externally gas-heated, vertical, brick retorts at 480° and 650° C., the coal inputs being 2·7 and 5·4 tons per hour respectively. Activation was performed in a retort similar to those used for carbonisation, maintained at 950° C. and fed with superheated steam in quantities varying from 1·4 to 3·1 times the weight of the coke charged. Working conditions were fixed at a feed of 140 lb. of coke per hour and a steam-flow yielding active carbon to the extent of 25 per cent. of the coke feed. Tests of the carbon made by the Chemical Defence Research Department showed it to be suitable for all types of respirators, and by crushing and sizing operations material applicable to solvent recovery and decolorisation work was obtainable. The quality of the latter was not comparable with that now generally employed in industry, but showed great promise. The respirator carbon is sized with an 8-18 B.S. Test sieve; for benzol recovery $\frac{1}{4}$ to $\frac{1}{8}$ in. material is commonly used; and for sugar decolorisation material is graded so as to pass a screen having 14 meshes per linear inch and be retained on a 60 mesh screen.

Cokes made from samples of Sherwood " Hards " at the Barnsley plant of Low Temperature Carbonisation, Ltd., yielded at Greenwich active carbons equal to those made in the Fuel Research Station, thus indicating that these low temperature carbonisation plants could in an emergency be readily adapted to active carbon manufacture.

The production of active carbon in this country is mainly from coconut shells, vegetable waste and bones, the first being the type used in respirators, and there is also a considerable import trade in activated carbon, largely from Germany. To date, the total quantity of carbon which has been employed in the civilian patterns of respirator cannot be less than about 6,500 tons. The normal consumption of new active carbon in the benzol recovery, solvent recovery, respirator, water purification and decolorising trades has been estimated at between 1,500 and 2,000 tons per year.

The prices of the various types of active carbon range from £18 to £120 per ton for decolorising grades, and up to as much as £400 per ton for the finest granular carbons for benzol and solvent recovery. Respirator carbons are selling in this country at present at £60 to £75 per ton.

United Kingdom—Carbons, decolorising and activated

	1932.	1933.	1934.	1935.	1936.
Imports	*cwts.*	*cwts.*	*cwts.*	*cwts.*	*cwts.*
Animal					
Germany	20	60	—	22	(*a*)
Netherlands	2,671	—	1,060	5	(*a*)
France	1,104	—	426	—	(*a*)
Other Foreign Countries	397	840	1,202	—	3,312
Total	4,192	900	2,688	27	3,312
Other					
Germany	1,691	3,136	1,149	2,524	1,535
Netherlands (entrepôt trade)	3,192	1,912	5,596	5,963	10,478
United States	985	—	2	3	379
Other Foreign Countries	990	292	448	598	1,583
Total	6,858	5,340	7,195	9,088	13,975
Re-exports	51	190	11	10	—
Domestic exports	6,252	25,572	9,066	6,765	6,781
Production	(*b*)	(*b*)	117,400	114,900	(*b*)

(*a*) *Included if any with Other Foreign Countries.*
(*b*) *Not available.*

NOTES

Exhibition Galleries.—In order to make the new "story" exhibits of products more attractive to the eye of the visitor, life-like models of the plants concerned are being introduced as a lead-off for these displays. The following are already installed and other models are in course of preparation:

In the Indian Court, as an introduction to the story of tea, two life-sized sprays of the tea plant modelled in wax have been added, one spray showing the flowers and fruits as well as the leaf, and the other the larger and more vigorous leaves that result from pruning.

In the East African Court has been arranged an excellent model of the passion fruit vine with life-sized leaves and flowers, and fruits in various stages of development from the small green ones that immediately succeed the flowers to the purple plum-like ripe fruits that fall when fully mature and become wrinkled after a few days exposure on the ground. The plant is trailing over wires stretched between two posts as it appears under cultivation in Kenya (see Plate V).

The South African Court has received an extensive collection of very fine wax models of the fruits cultivated in South Africa. These were modelled by Miss K. A. Lansdale, of the Department of Agriculture and Forestry, the cost being generously defrayed by the Citrus Fruit, Deciduous Fruit and Wine Growers' Associations of South Africa. These models are now in course of arrangement in the South African Court and an entirely new method of display is being adopted. Special scenic backgrounds portraying South African orchards have been painted, and over these are placed masks with circular openings in which are hung the realistic model branches of fruit. Below these models are painted scenes, in one case showing the transport by road and rail and the shipping of fruit in South Africa, and in the other the arrival of the fruit ship in London and the distribution of the fruit by road and rail. The models comprise apples, pears, plums, peaches, nectarines, apricots, citrus fruits, mangoes, litchies, papaws, persimmons, grenadillas, avocado pears, bananas and grapes.

Some excellent wax models of figs and oranges and lemons have also been received for the Malta Court; these are awaiting arrangement.

For the sugar exhibit in the British Guiana Court a scale model, one-quarter life-size, showing the cutting of sugar cane, has been installed as an introduction to the story of British Guiana sugar (see Plate VI).

It is hoped to extend these models of economic plants to other subjects, as funds for the purpose become available, as they are found to create considerable interest and to make a greater impression on the eye and mind of the visitor than the dried or preserved botanical specimens which were formerly used as illustrative material.

The following are other new additions to exhibitions in the Galleries:

In the Indian Court has been installed a showcase of veneered Indian Bombway (*Terminalia procera*) to house the diorama of tobacco cultivation which was described in a previous issue of this BULLETIN, 1938, **36**, 61.

The new diorama, entitled "On the Irrawaddy," which was constructed for the Irrawaddy Flotilla Co. in the Imperial Institute Studios for use at the Empire Exhibition at Glasgow, and referred to in this BULLETIN, 1938, **36**, 202, has now been installed in the Burma Court. The casing is of veneered teak and the descriptive label for the diorama reads as follows:

PLATE V

PASSION FRUIT VINE

Portion of Life-size Wax Model in the Kenya Court of the Exhibition Galleries of the Imperial Institute

PLATE VI

CUTTING SUGAR CANE

A Plaster Model ([illegible] scale) in the British Guiana Court of the Exhibition Galleries of the Imperial Institute

facing p. [illegible]]

Burma's Great Water-way, the Irrawaddy River

"This diorama shows one of the steamers of the Irrawaddy Flotilla Company at a typical calling place on the right bank of the Irrawaddy River in Upper Burma. It is the low water season and the shelving bank of the river is exposed. Villagers are embarking with their produce, and passengers who have left the steamer can be seen on shore where there is also a Burmese hut.

"In the distance can be seen another of the Company's vessels coming down-stream, while drifting down with the current is a teak log raft in charge of its crew. Flying over the hills in the distance to the right can be seen one of the Company's seaplanes, and dotting the landscape are a number of picturesque pagodas. The hills on the far side of the river are of sandstone with a curiously slanting formation, bearing only a scanty vegetation. The scene is in Burma's oil area and an oil derrick can be discerned on the sky line."

The relief model map of Burma showing the Irrawaddy River and the many calling places served by the Irrawaddy Flotilla Company's boats, which was also made on behalf of the Company for use at the Empire Exhibition, Glasgow, has now, through the Company's generosity, been placed with the diorama on semi-permanent loan in the Burma Court. The map rests on a veneered teak plinth.

Samples of Burma's agricultural produce, comprising cotton, food grains, oil seeds and oil-seed cake, have now been placed on exhibition.

A further display of exhibits from Travancore has been arranged in a newly-made wall showcase. The additional exhibits comprise coir fibre manufactures and a flag bearing the arms of the Travancore State.

A first consignment of exhibits for the new Aden Court has been received and displayed. The exhibits comprise samples of coffee, indigo, gum incense, gum olibanum, gum myrrh, beeswax, aloes, and mother-of-pearl shell.

A wall display of photographs illustrating the many uses of lead and lead products in the building and other industries has been arranged in the Australian Court with the aid of the Technical Information Bureau of the Lead Industries Development Council. The photographs have been grouped in eight columns on lead-paint backgrounds of different colours, to illustrate the uses of white lead, red lead and litharge, cast lead, extruded pipe lead, rolled or sheet lead, and the chemical, electrical and miscellaneous uses of lead. Other photographs show how white lead and red lead are made and the methods of casting, extruding and rolling lead.

To the Hong Kong Court have been added two groups of enlarged photographs, one illustrating the Hong Kong and Shanghai Bank and the other the new Jubilee Reservoir situated in the New Territories some 12 miles from Kowloon.

The Nigerian Court has received additional mineral specimens, including tin, tantalite, columbite, mica and gold, from Mr. A. R. A. Robertson, of the Mines Department.

Photographs for the East African Court have been prepared from negatives kindly loaned by Mr. J. G. M. King and Mr. T. H. Marshall, Agricultural Officers, Tanganyika.

From the Director of Agriculture, Nyasaland, have been received samples of Strophanthus seeds and of local varieties of maize, together with series of photographs illustrating tea cultivation and manufacture, tung oil trees and scenery in Nyasaland.

The Takoradi Harbour diorama in the Gold Coast Court, which had become out of date, has now been replaced by a new one showing the harbour as viewed from the sea.

Lord Lugard.—A bronze statuette of Lord Lugard is the latest addition to the collection of Empire Builders at the Imperial Institute. This was presented by members of the Royal African Society and was unveiled by Major-General the Earl of Athlone in the Nigerian Court on Monday, November 7, 1938. Its significance lies in the fact that it is the first statuette to be added to the collection of Empire builders in the Institute's Exhibition Galleries while the subject of it, one of our great administrators, is still living.

The statuette, of half life-size, is the work of Mr. Herbert H. Cawood, the sculptor who has been responsible for those of Cabot, Van Riebeeck, Brooke, Raffles and Livingstone already added to the collection in the past two years. It presents Lord Lugard standing in a very natural and easy attitude, in levee dress with sword, his right foot a little in advance of his left, and his hands lightly crossed in front of him, one holding a pair of gloves. In the dress the ribbon, badge and star of the G.C.M.G. are distinctly shown, together with other orders and decorations, including the Grand Cross of Leopold II of Belgium and the Commander of the Legion of Honour (see Plate VII). A panel in the black pedestal on which the figure stands gives a brief outline of his career.

In asking Lord Athlone to unveil the statuette and to present it to the Imperial Institute, Sir Henry Galway, Vice-President of the African Society, spoke as follows:

" We have come here this afternoon to unveil a statuette of Lord Lugard and to present it—on behalf of the Royal African Society, of which Society he is Vice-President and Gold Medallist, and of some present and past Nigerians—to the Imperial Institute, to add to their collection of statuettes in

PLATE VII

The Right Hon. LORD LUGARD, P.C., G.C.M.G., C.B., D.S.O.

A Bronze Statuette in the Nigeria Court of the Exhibition Galleries
of the Imperial Institute

[*facing page* 506

these Galleries, which includes other great African benefactors: van Riebeeck, David Livingstone and Cecil Rhodes. This is the work of Mr. Herbert Cawood and, I think, when it is unveiled you will all agree that it is an excellent portrait of this great Englishman and African—done from life to-day, but representing him as he was when he retired from active service in Africa—the Lugard whom the Africans remember so affectionately. Lord Lugard, however, is the first living person to be so represented in this collection, and the Royal African Society is proud to be associated in this presentation and to take a share in such an historic occasion.

" I will now call on Lord Athlone as President of the Society to unveil this statuette, and will ask him to present it, in the joint name of the Society and the associated donors, to Sir Harry Lindsay, Director of the Imperial Institute, to be kept here as a memento of one whom we delight to honour."

Lord Athlone said:

" I have great pleasure in asking you to accept, on behalf of the Imperial Institute, this statuette of Lord Lugard. It is not necessary for me to sing his praises. He is too well known all over the world for that—in the British Empire, in Europe, at the League of Nations, in America, and most of all, in Africa—where, though he is happily still with us, his name is held in almost legendary respect and affection. Africa has known him since he was a young lieutenant: in Nyasaland, in Uganda, and then in Northern Nigeria which was his creation, and after sojourns elsewhere—back again in a united Nigeria to consolidate where previously he had laid the foundations. There stands his greatest monument, and it is fitting that this statuette should be placed in the Nigerian Court in your Galleries.

" Lord Lugard is also known to us all by his greatest book—which became a classic at its birth—*The Dual Mandate*; he is known to us as the Father of Indirect Rule—Britain's chief contribution to the solution of African problems. He is known to us and respected by us above all as a wise guide and counsellor; the doyen of the elder statesmen of Africa, and although he is, as Sir Henry Galway has said, the first living man to be represented in this admirable collection of statuettes which you are forming, I think it will be agreed that there is none who better merits inclusion in this new Valhalla of our Empire.

" I ask you in the name of the Royal African Society and of his other friends to accept this statuette and I hope that many will pay a pilgrimage here to see it, placed as it is in the midst of all this evidence of what Nigeria owes to him."

In accepting the statuette on behalf of the Imperial Institute Sir Harry Lindsay said:

" My Lord, Ladies and Gentlemen, may I say at once, on behalf of the Board of Governors of the Imperial Institute and on my own behalf as Director, how exceedingly grateful we are for this gift ? As Sir Henry Galway has remarked, we already have statuettes of Empire builders in other Courts of these Exhibition Galleries ; but the West African Court has for long been bare. When, therefore, Mr. Nicholson suggested last year that the gap might be filled with the co-operation of the Royal African Society and that the choice would fall on Lord Lugard, you can imagine how delighted we were.

" We have always been anxious to tell in these Galleries the story—an illustrated story—of each country of the Overseas Empire, not only in its social, geographical and industrial aspects, but also to some extent in its historical aspects as well. Of course we cannot tell the whole history of each Dominion or Colony ; that is a matter for the history books. But one thing we can do, and that is to show by means of these statuettes, each in its appropriate Court, who were the outstanding heroes who helped to build up this Empire of ours. We started with Clive for India, Cook for Australia, and Rhodes for Rhodesia. We have been able, with Mr. Cawood's help, to add Cabot for Newfoundland, Van Riebeeck for South Africa, Raffles for Malaya, Rajah Brooke for Sarawak, Livingstone for East Africa ; and we have orders for Gordon and Kitchener for the Sudan, Godley for New Zealand, Labourdonnais for Mauritius. I hope, as a result of my recent visit to Canada, to secure statuettes of Vancouver and Wolfe for the Canadian Court ; and later on, perhaps we may get Governor Phillip for Australia, Drake and Raleigh for the West Indies.

" Lord Lugard's is the first statuette of a living Empire-builder, and I am sure you will all agree with me that his wonderful record, both as pioneer and as administrator, fully justifies this place which we are now giving him amongst his illustrious predecessors."

Colonial Visitors.—The following is a list of officers on home leave from the Colonies who have visited the Institute during the three months August-October 1938 :

AUGUST

R. C. ALLEN, Superintendent of Education, The Gambia.
H. W. AMARASURIYA, Member, State Council, Ceylon.
F. S. DANKS, Assistant Conservator of Forests, Cyprus.
M. V. EDWARDS, Assistant Conservator of Forests, Burma.
A. E. GILLIAT, C.I.E., I.C.S., Commissioner, Burma Civil Service.
R. M. GRAHAM, Assistant Conservator of Forests, Kenya.
R. S. MACKILLIGIN, O.B.E., M.C., Inspector of Mines and Petroleum Technologist, Trinidad.
F. OATES, M.B.E., Chemist and Petrologist, Lands and Mines Department, Tanganyika Territory.
R. PATTERSON, Inspector of Mines, Nigeria.

A. **Pitcairn**, Assistant Director of Agriculture, Cyprus.
P. B. **Quinlan**, Director of Public Instruction, Burma Education Service.
Hon. Mr. D. S. **Senanayake**, Minister of Agriculture and Lands, Ceylon.
M. **Shapiro**, Technical Sheep Officer, Government Stock Farm, Palestine.
Miss A. **Nicol Smith**, Peace Memorial Museum, Zanzibar.
C. **Swabey**, Forest Officer, Jamaica.
Sir **Edmund Teale**, Mining Consultant, Tanganyika Territory.

SEPTEMBER

F. G. **Browne**, Assistant Conservator of Forests, Malayan Forest Service.
A. J. S. **Butterwick**, Deputy Conservator of Forests, Burma.
G. F. **Clay**, O.B.E., Assistant Director of Agriculture, Nigeria.
H. A. **Hay-Barclay**, Veterinary Officer, Nigeria.
Dr. N. R. **Junner**, O.B.E., M.C., Director, Geological Survey, Gold Coast.
E. W. **Leach**, Agricultural Officer, Nigeria.
G. G. **Masson**, Chief Agricultural Officer, Palestine.
G. W. **Nye**, Senior Botanist, Agricultural Department, Uganda.
A. S. **Richardson**, Deputy Director of Agriculture, Uganda.
B. E. **Smythies**, Assistant Conservator of Forests, Burma.
Sir W. T. **Southorn**, K.C.M.G., K.B.E., Governor, The Gambia.
W. A. **Watson**, Chemist, Department of Agriculture, Nigeria.
M. M. **Wedderburn**, C.M.G., Chief Secretary, Ceylon.
F. W. **Winckley**, Tobacco Specialist, Jamaica.

OCTOBER

H. W. **Claxton**, O.B.E., Treasurer and Chief of Customs, Somaliland.
Professor L. **Forster**, Professor of Education, University of Hong Kong.
Dr. J. M. **Hall**, M.B.E., Assistant Director of Medical Services, Jamaica.
N. U. **Jayawardene**, Commercial Assistant to Director, Department of Commerce and Industries, Ceylon.
Professor R. **Robertson**, Professor of Economics and Political Science, University of Hong Kong.
Dr. F. L. **Squibbs**, Director of Agriculture, Seychelles.
F. E. **Stafford**, O.B.E., Principal Assistant Secretary, Nigeria.
J. F. **Ward**, Agricultural Officer, British Honduras.
E. S. **Willbourn**, Director, Geological Survey, Federated Malay States.

All Dominion and Colonial officers, as well as private residents overseas, who may be visiting London are cordially invited to come to the Institute to see our Exhibition Galleries, and to discuss scientific and technical problems in which they may be interested.

Twelfth International Horticultural Congress.—At this Congress, which was held in Berlin from August 12 to 17, 1938, the United Kingdom was officially represented by a delegation headed by Dr. Taylor, Horticulture Commissioner of the Ministry of Agriculture and Fisheries, and including representatives of the Colonial Office, the Imperial Agricultural Bureaux, the Royal Botanic Gardens, Kew, the Royal Horticultural Society and the Imperial Institute.

A large number of papers contributed by delegates from 50 countries and covering a wide range of subjects had been submitted for consideration at the Congress and in order to complete the programme in the allotted time, the proceedings were divided into 20 sections each dealing with a different subject. As it was not possible for every paper to be presented in full, one or more delegates from the participating countries had been appointed as General Reporters in each section and delivered to their respective sections reports which summarised the information embodied in the papers contributed by the various countries. Summaries in English, German, French and Italian of individual papers were, however, available to all participants in the Congress. The presentation of the general reports was followed by discussion.

Among the various subjects dealt with may be mentioned the following: tropical and sub-tropical fruit growing, storage of fruit and vegetables, processing and industrial utilisation of fruits and vegetables, spice, scent and medicinal plants, application of growth promoting substances, plant protection and market regulations.

It is hoped to publish the papers and proceedings of the Congress either at the end of this year or the beginning of next.

At the conclusion of the Congress many members took part in specially arranged tours of various districts of Germany of horticultural and agricultural interest. The tours finished at Essen where the Reich Garden Show was held on August 21.

Relation of Cobalt to certain Animal Diseases.—Sheep and cattle grazed on certain pastures have for many years been subject to diseases of the " pining " type. Certain of these diseases, such as " bush sickness " in New Zealand, " coast disease " and enzootic marasmus in Australia, were very widespread and their effect was of considerable economic importance. Until very recent years diseases of this type were being treated, particularly in Australia and New Zealand, as iron-deficiency diseases, but the success of the treatment applied was found to vary very considerably with the source of the iron. Certain samples of limonite, for example, when incorporated in salt licks, were found to be effective in controlling " bush sickness," while others, of similar iron content and physical character, were of no value for this purpose. It was therefore considered possible, especially when treatment with very carefully purified iron salts, even in large amounts, was found to be ineffective, that some minor constituent might be of more importance than the iron.

Striking results were obtained by workers in Australia in the treatment of " coast disease " and of enzootic marasmus with minute quantities of cobalt salts (A. R. Marston, *J. Coun. Sci. Ind. Research, Australia,* 1935, **8**, 111 ; E. W. Lines, *ibid.*, 117 ; E. J. Underwood and J. F. Filmer, *Australian Vet. J.*, 1935, **11**, 84). It was also shown that the acid extract of certain New Zealand soils, which formed a successful treatment for bush sickness, contained minute amounts of metallic elements such as cobalt, nickel and copper (T. Rigg and H. O.

Askew, *Empire J. Exp. Agric.*, 1936, **4**, 1). Subsequent investigations showed that direct treatment with cobalt salts in very small amounts formed a satisfactory treatment for animals suffering from these diseases.

Since the actual amount of cobalt required per head is very small, and should not be exceeded owing to the toxic character of large quantities, efforts were made to supply cobalt to the grazing animals by increasing the cobalt content of the pasture plants by means of top dressing with cobalt salts (H. O. Askew and J. K. Dixon, *N.Z. J. Sci. Tech.*, 1937, **19**, 317), as it had already been shown that plants readily absorbed cobalt when grown in soil treated with cobalt chloride. It was demonstrated that quantities as small as 2 lb. of cobalt chloride per acre markedly increased the cobalt content of the pasture plants (H. O. Askew and P. W. Maunsell, *N.Z. J. Sci. Tech.*, 1937, **19**, 337). The most effective method of applying the cobalt top-dressing was by mixing a solution of the required amount of cobalt salt with a large quantity of superphosphate (about 2 cwt. per acre).

The ability of pastures to prevent the onset of these diseases appears to be correlated with the cobalt content of the actual plants grazed (C. S. M. Hopkirk, *N.Z. J. Agric.*, 1938, **56**, 21), although the correlation of the diseases with the cobalt content of the soil itself is not so well defined (E. B. Kidson, *N.Z. J. Sci. Tech.*, 1937, **18**, 694).

Special cobaltised salt for incorporation in salt licks for cattle and sheep is now being prepared in New Zealand (Hopkirk, *loc. cit.*). This contains 4 oz. of cobalt sulphate to 18¾ lb. of salt, with 1 lb. of haematite added to colour it bright red. This is intended to be used at the rate of 1 lb. to 1 cwt. of agricultural salt, the red colour forming a guide to the completeness of the mixing.

It has recently been very tentatively suggested that a sheep disease of the " pining " type which occurs in certain localised areas of Dartmoor may also be due to cobalt deficiency, although this is not yet certain. This disease shows the unusual feature of affecting certain breeds of sheep while others are apparently immune (J. B. E. Patterson, *Empire J. Exp. Agric.*, 1938, **6**, 262).

It has been shown that in certain cases the use of a mixture of nickel and cobalt salts is more effective than the use of cobalt salts alone when administered directly to the affected animals (J. K. Dixon, *N.Z. J. Sci. Tech.*, 1937, **19**, 326).

Certain recent work indicates that cobalt alone may not be effective in curing these diseases, but that the essential treatment must include copper as well as cobalt (H. R. Marston, E. W. Lines, R. G. Thomas and I. W. McDonald, *Nature*, 1938, **141**, 398; Marston, Thomas *et al.*, *Council Sci. Ind. Research, Australia, Bull. No.* 113, 1938).

This work is being continued, particularly with a view to delimiting the areas where cobalt-deficiency is likely to occur (*N.Z. Dept. Agric., Ann. Rept. for* 1937-38, 57; *N.Z. Dept. Sci. Ind. Research, 12th Ann. Rept.*, 1938, **11**, 36-38).

Manganese.—A new and entirely rewritten edition of the Imperial Institute monograph on Manganese was issued on October 19 (Royal 8vo, boards, 164 pp., price 3*s.* 6*d.*). This work, by A. W. Groves, D.Sc.(Lond.), has been prepared on the same lines as others in the well-known series of monographs on the mineral industry, and treats principally of the world resources of manganese ore (no less than 55 countries being dealt with) and lays special emphasis on Empire deposits.

In addition to the important subject of resources, it contains a large amount of information of a more general character and deals fully with the mineral composition, classification, impurities, mode of occurrence, mining and concentration, uses, marketing, trade and production. It includes extensive tables of statistics covering production, imports and exports of metallurgical ore, battery ore, ferro-manganese, spiegeleisen and other ferro-alloys, which together with chemical analyses of ores constitute over 40 pages of the document. A detailed bibliography occupying 20 pages is appended.

Manganese ore is scarcely less essential to the iron and steel industry than iron ore and coal, for it is computed that on the average about 30 lb. of high-grade manganese ore are consumed for each ton of steel produced and no acceptable or adequate substitute has yet been discovered, nor is any in prospect. The addition of manganese, in the form of ferro-manganese, to steel has a twofold purpose: first as an indispensable aid in the manufacturing process and secondly the surplus acts as an alloy element imparting certain desirable properties to the finished steel.

High-manganese steel has extraordinary resistance to abrasion and is therefore used in many parts subjected to severe mechanical conditions such as railway points and crossings, sprockets, clutches, rock crushers, bucket lips of excavators and dredges and for many other items of mining machinery. The high-tensile structural steels contain manganese and so do the rails on our railways. Manganese to the extent of a few per cent. is a constituent of a very large number of alloys, both ferrous and non-ferrous; among the latter are special brasses and bronzes, including manganese bronze used for ships' propellers, and the light metal alloys, the applications of which are rapidly growing. Considerable quantities of high-grade pyrolusite are consumed by the dry battery, glass, ceramic, paint, varnish and chemical industries.

Large-scale production of manganese ore is confined to the

U.S.S.R., India, the Gold Coast, the Union of South Africa, Brazil, Egypt and Cuba. Excluding Russia, it is noteworthy that the United Kingdom and the other great iron- and steel-producing countries of Europe, as well as the U.S.A. and Canada, have to rely almost entirely upon imports from distant lands for their essential supplies of manganese ore of metallurgical grade. Likewise, with the exception of the U.S.S.R. and the U.S A., the principal industrial countries of the world are poorly endowed with manganese ore of battery or chemical grade. It follows that the bulk of the world's consumption of manganese ore is ocean-borne.

The British Empire is favourably situated with regard to supplies of manganese ore, the reserves in India, the Gold Coast, Union of South Africa and Malaya reaching a vast total. In 1936 29 per cent. of the world's production of manganese ore was from Empire countries, but 61 per cent. of the exports came from Empire countries.

A full-page graph contrasts the world steel output with both world and Empire manganese-ore production for the period 1920 to 1936 inclusive.

Those interested in the manganese ore industry, whether as consumers, producers, brokers, or students of economics, will find in this book a concise, up-to-date and authoritative account of this essential commodity, plus an abundance of statistical data.

British Guiana Bauxite Deposits.—Mr. D. W. Bishopp, of the Geological Survey of British Guiana, has compiled a "Memorandum on the Occurrence of Bauxite in British Guiana," the bulk of which has recently been published as *Geological Survey Bulletin No.* 8. It has been compiled from a series of reports, letters, memoranda, Government publications and press articles by various authors between 1910 and the present date. Unfortunately it has proved impossible to include up-to-date information relating to the deposits now being worked on the Demerara River. These deposits are at present being exploited on a large scale by the Demerara Bauxite Company, who are the only producers in the colony, as the British and Colonial Bauxite Co. are not at present working the deposits they hold on lease from the Government beyond the minimum demanded by the terms of their contract.

The bulletin describes briefly the historical development of the bauxite deposits, devotes considerable space to descriptions of the various deposits which have been examined and concludes with a theoretical discussion on the geology and origin of bauxite. It consists very largely of a list of the districts visited by E. E. Winter and Sir J. B. Harrison prior to 1921, giving references to their appropriate reports, with tonnages indicated, analyses and a statement of the present owners and production, if any. Altogether 24 localities are listed, 5 on the Lower Essequibo River, 13 on the Demerara River, 3 in the Berbice district, 1 in the Corentyne district and 2 in the North-West District. A map of the "Northern Portion of British Guiana" shows the bauxite localities described.

Although no new or original work is described, the usefulness of this bulletin lies in the fact that it summarises in one volume information which is otherwise difficult of access; several unpublished reports have been consulted in its compilation. A list of published and unpublished reports consulted is included as Appendix No. 2.

The bauxite resources now being developed in British Guiana were briefly described in a paper by Dr. E. C. Harder entitled "British Guiana and its Bauxite Resources," published in the *Canadian Institute of Mining and Metallurgy Bulletin*, November 1936.

The Canadian Gold Mining Industry in 1937.—In 1937, for the third year in succession, the production of gold in Canada surpassed all previous records, the output of new or primary gold from all sources amounting to 4,096,213 fine oz. in 1937 as compared with 3,748,028 fine oz. in 1936. Canada now ranks as the third most important gold producing country in the world after the Union of South Africa and the U.S.S.R.

All the provinces in the Dominion showed increases in production with the exception of the Yukon and Alberta, the leading producers being Ontario, Quebec and British Columbia, in that order. Of the total quantity of gold recovered, 80·2 per cent. was contained in gold bullion produced at the mines, 11·7 per cent. in blister copper, 5 per cent. in ores, matte, etc., exported, 2·2 per cent. in crude placer gold and 0·9 per cent. in base (lead) bullion.

The estimated average price of $34·99 per fine oz. was slightly below the 1936 figure of $35·03.

The alluvial gold mining industry in the Dominion is located principally in the Yukon and British Columbia. In the former locality 58,349 oz. of crude gold were recovered, a decrease of over 4,000 oz. compared with the 1936 figure. In British Columbia, on the other hand, output increased from 43,389 oz. in 1936 to 54,153 oz. in 1937 and much more interest is being taken in placer mining in this province than has been the case for many years.

Auriferous quartz mining, however, provides by far the bulk of the gold produced in Canada. In Quebec practically all the producing mines showed substantial increases over 1936 and a considerable amount of work was done on prospecting and development of new properties. Development and exploration work was also intensified in Ontario in 1937 and notable events in this province during the year included the erection of new plant at Kirkland Lake and the start of a programme of expansion at the Cline Lake mine, Algoma district. Production increased also in Manitoba and Saskatchewan, the latter showing an increase of about 37 per cent. over the 1936 figure. Increases were also reported from British Columbia and the North-West Territories.

The mining of copper-gold-silver ores in 1937 was confined to Quebec, Manitoba, Saskatchewan and British Columbia. At 456,348 fine oz. the amount of gold recovered from this source was somewhat less than in 1936 when the figure was 495,284 fine oz.

The above facts are contained in the recently issued *Summary Review of the Gold Mining Industry in Canada*, 1937, published by the Dominion Bureau of Statistics, Ottawa. Short statements on the gold mining industry in other countries are also given in the review, which concludes with a very valuable and comprehensive list of the principal Canadian gold producers, their head office addresses and the location of their properties.

Sulphur Recovery at the Trail Plant, B.C.—The Trail Metallurgical Plant of the Consolidated Mining and Smelting Co. of Canada, Ltd., treats the mixed lead-zinc sulphide ores from the Sullivan Mine. These yield by water-concentrating and flotation processes both lead and zinc concentrates which are separately roasted.

The furnace gases were formerly discharged into the atmosphere, but as this involved the Company in expensive litigation with farming interests on both sides of the international boundary, on account of damage done to crops by the sulphur dioxide (SO_2), it was decided to recover this gas, to convert it into sulphuric acid, and to utilise the acid in the production of a range of phosphorus and nitrogen fertilisers.

Operations commenced with a small pilot acid plant in 1929, which has, from time to time been increased so that the output grew from 2,727 long tons of acid in 1929 to 117,653 tons in 1937; the acid plant is being increased further to have a capacity of 600 tons a day.

The small amount of SO_2 in the gases from the lead concentrate roasters, however, could not be economically converted into sulphuric acid, so the Company decided to attempt to convert it into elemental sulphur.

After much research a pilot sulphur recovery plant was built in 1935; this has steadily increased in capacity and in 1937 the output of elemental sulphur reached 12,045 tons. It is expected that production will be increased before long to 200 tons a day.

The progress of the sulphuric acid and fertiliser industries at Trail has been described in the technical press from time to time. A recent article by S. D. Kirkpatrick in the September 1938 issue of *Chemical and Metallurgical Engineering* describes the recently installed sulphur recovery plant.

The roasting plants at present discharge in the form of SO_2 the equivalent of about 400 tons a day of sulphur, of which 240 tons taken from the zinc roasters are diverted to the sulphuric acid plant. The balance of 160 tons is all absorbed, as described below, and divided, according to varying demands, between the production of elemental sulphur and of sulphuric acid. The gas issues from the roasters at a temperature of 350° C. and is first of all freed from dust by being passed through plate-type Cottrell electrostatic precipitators, the plates being 8 in. apart and the negative plates charged at 45,000 volts. A tapping device removes dust from the positive plates, which goes to waste.

The cleaned gases are next passed through a series of brick-packed cooling towers, 20 ft. in diameter and 28 ft. high. The cooling liquid is a 15 per cent. sulphuric acid solution which gravitates through the packing at the rate of 10 lb. per sq. ft. per minute.

The cleaned gases, now cooled to the optimum temperature of 40° C., are delivered by motor-driven blowers of an aggregate of 100 h.p. to the first of four absorption towers in series, each 17 ft. square and 30 ft. high, of wood construction, sheathed in lead externally and filled internally with wood plank packing. The gases pass alternately upwards and downwards through the packing, where they come in contact with a circulating solution of ammonium sulphite which dissolves the SO_2 and is converted into bisulphite. As the ammonium bisulphite solution gradually increases in strength to a concentration of between 5 and 6 lb. of SO_2 per gallon, some of the liquor is drawn off and replaced by liquid ammonia.

The necessary uniform temperature of the solution is carefully controlled by circulating it through aluminium tubes, externally water cooled, the heat of reaction being thus absorbed.

The liquor which is drawn off from the absorption plant, containing mainly ammonium bisulphite as well as a small amount of SO_2, after clarification in plate and frame filters is delivered to the acidifying tower, a cylindrical tank. Strong sulphuric acid is added, the resulting ammonium sulphate being produced in almost saturated solution with some occluded SO_2.

The liquor is pumped to a series of SO_2 eliminators where the gas is driven off by steam, then cooled, dried and filtered. It is then ready for the reduction plant which actually is a gas producer employing coke fuel.

The sulphur dioxide, to which a small amount of pure oxygen from the Company's liquid air plant is added, is here reduced by the incandescent coke to elemental sulphur. Carbon dioxide, carbon oxysulphide, carbon monoxide, and sometimes carbon bisulphide are formed in addition. The mixed gases and sulphur are partially cooled, and then go on to a catalyst column, where by means of a small addition of sulphur dioxide the carbon oxysulphide is reduced to elemental sulphur.

After further cooling liquid sulphur and mist sulphur result. The latter is treated in a pipe-type Cottrell precipitator and converted into liquid sulphur.

The joint liquid sulphur product is of 99·99 per cent. purity, but being slightly off-colour through a minute amount of occluded carbon, is filtered and, while still in a liquid state, is pumped from steam-heated storage tanks, either to the sulphur storage pile, where over 20,000 tons is already accumulated, or to a flaking apparatus which produces a fine-grained product.

The sulphur is sold mainly to farmers for crop dusting and to the paper and pulp industry.

United States Asbestos Supplies.—In so far as asbestos is virtually a necessity in the automobile industry, and as modern fighting forces are becoming increasingly mechanised, asbestos may be regarded as a strategic mineral. The position of the United States with respect to supplies of asbestos has therefore been reviewed by Oliver Bowles in an article, "Asbestos—a Strategic Mineral," in the October 1938 issue of *Mining and Metallurgy* (pp. 442-445). He draws attention to the fact that from the standpoint of national self-sufficiency conditions are far from satisfactory, for at present the United States is only producing 3 to 4 per cent. of its domestic requirements, the remainder being imported chiefly from Canada, British Africa and U.S.S.R. It is often assumed that this is of little consequence since abundant supplies are available in Canada, but the author points out that although adequate supplies of short fibres have always been obtained from this source, it furnishes only a small percentage of the best grades, and it is this class of fibre which is so important for the manufacture of brake and clutch linings, gaskets, packings, fireproof suits and other fabrics. In 1937 only 18 per cent. of the total imports of crude asbestos came from Canada, the rest being shipped from more distant sources.

There are three possible methods of meeting the demand;

firstly, by an increase in the Canadian production; secondly, by stimulating domestic production; and thirdly, by the use of substitutes. The possibility of manufacturing asbestos artificially does not arise, for although it has been claimed, especially in Germany, that synthetic asbestos is a commercial possibility, there is so far no practical evidence to support the claim.

For the last four years two-thirds of the Canadian sales of crude asbestos have been to the United States and it is therefore evident that the total Canadian production of this grade is far below the normal needs of manufacturers in the United States. It is evident that Canadian production could only be stimulated to a limited degree, for a marked increase in the output of crude would necessitate a corresponding increase in the output of all the shorter grades which would be economically undesirable. However, considerable quantities of spinning fibre, the highest grade Canadian mill fibre, are normally imported and this quality might be substituted for crudes for many uses.

As regards the possibility of stimulating domestic production, at present there is little prospect of any marked increase in the production of long fibres. Vermont and Arizona are the only consistent producers of chrysotile, but the Arizona production has been exceedingly small during recent years and although Vermont's output is making substantial gains, non-spinning fibres only are being mined. The Arizona deposits furnish excellent crude fibre; mining costs, however, are generally high, transportation is difficult and freight charges to the large eastern markets are excessive. It has not yet been demonstrated that these deposits could furnish a large supply, even under intensive stimulation. The Vermont deposits are extensive and could produce large quantities of mill fibres of moderate to short lengths, but little of spinning grade. Although chrysotile deposits are known in California and some other States, none appear to be capable of development into consistent producers of a large tonnage of spinning fibre.

The last possibility is the substitution of other materials for the major uses of asbestos. Synthetic fibres, such as mineral wool, slag wool and glass wool, are manufactured in large quantities with increasing refinements; as such materials are being used extensively for heat insulation, their encroachment on some branches of the field now occupied by asbestos seems inevitable.

Propane and Allied Fuels.—In the operation of petroleum wells a variable quantity of natural gas, representing the more volatile hydrocarbons, issues often at pressures of great magnitude. This mixture of hydrocarbons contains not only pentane, hexane, heptane, etc., which are valued as natural gasoline, but also the lower members of the series such as propane and butane which, on account of their excessive volatility, must be excluded from spirit to be employed as petrol. Originally the practice was to allow this natural spirit, then known as " casing-head spirit " because it was drawn off from the top of the casings of oil wells, to " weather," when the undesirable dissolved fractions (unfortunately, together with a large proportion of the valuable fractions) evaporated at normal temperature and pressure. Present-day separation practice consists either in compressing and cooling the gas, dissolving it in a suitable liquid somewhat less volatile than kerosene, or absorbing the less volatile fractions with activated carbon. By each of these three methods large quantities of propane and butane are accumulated and in the United States, where the quantity of natural gas available is enormous, special industrial and domestic outlets for propane and butane have been developed. An account of the entire business has been recently published (*U.S. Dep. Comm., Nat. Bur. Stands., Circ.* 420, 1938, 21 pp.).

In the United States the sale of these petroleum gases, which owe their utility to the fact that they can be readily liquefied, commenced in 1926, with a total of 466 thousand gallons, and by 1937 the propane sales amounted to 46,474 thousand gallons, those of butane 45,504 thousand gallons and of mixed gases 46,694 thousand gallons. In addition 2,833 thousand gallons of pentane were sold. At first these gases were sold as mixtures, but the merits of each individually soon became apparent and separations were effected by means of fractional distillation. Much of the quantity now used is still obtained direct from natural gas, but the oil-refineries could greatly augment supplies if the demand was forthcoming. At present at such plants the gases are converted to petrol.

Butane and propane provide domestic consumers with a gas service for cooking, lighting, water heating and refrigeration where no supply of town gas exists. For this purpose the gases are normally filled into small cylinders or " bottles," which in the United States usually contain 100 lb., whereas in the United Kingdom a 28 lb. bottle is the normal size. Two bottles are usually maintained in each installation so that a change-over can be made without interrupting the supply.

In this country the gas distributed is butane extracted from the products of the hydrogenation of coal carried out at Billingham. This gas has a calorific value at N.T.P. of 3,447 B.Th.U. per cu. ft., as compared with 2,654 B.Th.U. for propane, but the relatively high boiling point of the liquid (1° C.) renders it unsuitable for general use in the United

States where very low winter temperatures prevail in many parts of the country and where it is a common practice to keep the "bottles" out of doors. As a consequence propane is much more widely employed there, despite its lower calorific value, since its boiling point as a liquid is as low as – 45° C.

It is said that these gases exert a corrosive influence on the jointing compounds normally used in town-gas plumbing, and therefore may not safely be serviced through mains designed primarily for that purpose. The price of the gas marketed in the United Kingdom is in the vicinity of 2*s.* 3*d.* a therm, a 28 lb. cylinder costing 15*s.* to refill. In the States an equal weight would cost between 7*s.* and 12*s.* according to the locality of consumption.

The presence of lower hydrocarbons in a member of the series, such as ethane in propane, or propane in butane, has a marked effect upon the safe and efficient combustion of the gas. A little ethane may cause a considerable amount of trouble from "striking-back" or blowing from the burner ports when a new cylinder is started, and similar defects are liable to occur when propane is a diluent in butane. On the other hand the presence of a fuel of a higher calorific value in one of lower value results in inadequately aerated flame jets and incomplete combustion, with a possible production of carbon monoxide.

In the United States pentane and butane are also widely used in industrial heating and for various specialised purposes in chemical plants.

Portable Charcoal Kilns.—The old heap or meiler process for making charcoal, which has been in use from time immemorial, is slow and costly and requires constant and careful control, without which poor fuel results.

In certain countries, where there is an abundant cheap supply of timber and where petrol is very expensive and of uncertain supply in time of war, the use of charcoal for mobile power purposes has become a matter of importance. Consequently a demand has arisen for a handy, easily portable charcoal kiln which can produce a fuel of good quality with avoidance of trouble connected with tar, dirt, etc.

An article on this subject by N. C. Jones has recently appeared in *The Industrial Chemist* (October 1938) in which a number of the best-known types of portable charcoal kilns of British, American and French design are described. Abstracts from the descriptions of a few of the simpler types are given as follows:

The Hornsby Kiln.—This is made in five sizes, the smallest being 3 ft. 4½ in. in diameter by 6 ft. 4 in. high, the largest 6 ft. in diameter by 10 ft. high, the corresponding outputs of charcoal being 400 and 2,500 lb. per 24 hours. Construction is simple; the kiln consists of an outer mild-steel shell, which may be lined with firebricks, and a top consisting of a steel lid which, being attached to an iron swivel arm on a bracket fixed to the side of the shell, can easily be swung out of the way. A hinged door at the bottom enables the charcoal to be easily removed, as the kiln is supported clear of the ground on four legs. A row of internal firebars above the door is used to support the charge.

The kiln is in sections, and both dismantling and re-erection are simple. Vent holes with cast iron frames and sliding doors are placed round the shell at different heights. Inside, an angle curb is fitted to protect the top of the brick lining. The costs of the different sizes of the kiln complete with legs vary from about £45 to £100.

The Mobyl Transportable Retort (B.P. 477,058).—This is also cylindrical, being 5 ft. in diameter by 6 ft. deep. Its chief feature is its base of two concentric steel-plate rings 4 in. deep and spaced 3 in. apart by distance studs. The space between them is filled with sand or soil upon which rests the outer shell of the kiln, and concentrically with it an inner shell, acting as a baffle plate, 3 ft. deep, a small space being between them.

The outer shell is in four sections, the joints being covered inside and out with plates 5 in. wide the full depth of the shell, brought together from the outside with screwed studs. In each plate, 18 in. above the bottom, is an orifice to which is fitted outside a vertical chimney with a butterfly valve. Nine U-shaped inlet pipes, up-turned and buried in the ground below the base rings, the inner legs being covered with conical deflectors, permit of the admission of air into the interior of the retort. A firing pipe is provided in the centre of the kiln.

The roof of the retort is a domed iron plate and rests in a bed of sand in a channel at the top of the shell outside. The roof is supplied with the usual circular holes provided with cover plates. Internally the four chimney exits are protected by the inner steel shell, referred to above.

The total weight of the retort is 9 cwt.; the four side sections of the outer shell weight 1 cwt. each. Wood up to 30 in. in length and of ½ to 5 in. in diameter is recommended.

Buchanan-Harris Kiln (B.P. 374,051).—This has been developed by the Forest Products Research Department at Princes Risborough.

Its chief characteristic is its portability, each component part being kept down in weight to a one-man load for a short distance. The cost of erection is small as all joints are boltless and smoke-tight, special covering tubes filled with sand or earth being used.

The cylindrical shell of the retort is made up of 12 sections weighing 149 lb. each, and the roof of 6 sections less than ½ cwt. each. As with the Mobyl retort, a number of U-shaped air inlet pipes are placed beneath the shell.

A notable property of the kiln is that when carbonisation is complete, which is shown by the emission of blue smoke and the even heat of the kiln, the air intakes are fully opened for half an hour to raise the temperature of the charge to a uniform point. This results in the production of a hard charcoal of even quality. The kiln is then closed down and allowed to cool. A cycle takes 48 to 66 hours. Wood from 1 in. to 3 in. in diameter is generally used, but larger diameters up to 8 in. are permissible. A good yield is made with a low percentage of smalls.

Trihan Portable Kiln.—This French retort is made in three sizes which treat 1, 6, or 12 cu. metres of packed wood. The smallest size consists of a steel shell, 4 ft. 3 in. in diameter and 2 ft. 6 in. high, supplied with draught holes round the bottom and a conical lid which rests on a ledge containing sand inside the shell at the top. A central chimney passing through the lid and reaching nearly to the bottom of the shell acts as a conductor for the fumes produced. Outside, at the bottom, is a ring of steel plate 8 in. deep, larger in diameter than the shell. The precise admission of air to the space between is controlled by segmental rings resting on cleats. The yield is 130 to 180 lb. of charcoal per cycle of 24 hours.

The largest size of Trihan kiln consists of eight steel panels, either cylindrical or octagonal, and is 9 ft. 8 in. in diameter by 7 ft. 3 in. deep. It is supplied with controlled air supply holes at the bottom and fume exists in the cover in addition to a central chimney. It is easily dismantled, the parts being conveniently portable.

Calcium Sulphate Plasters.—The variety of gypsum plasters now marketed has become so extensive of late that the Building Research Station has thought it advisable to issue a summary of the types available and their respective applications (*D.S.I.R.*, *Building Research Bulletin*, No. 13, 1938).

The plasters are divided into two groups: hemi-hydrate or plaster of Paris types in which the gypsum has been lightly calcined at about 170° C., and anhydrous types formed of gypsum completely dehydrated by calcination at 400° C. or over, or made from the naturally occurring anhydrous calcium sulphate known as anhydrite. Further subdivision is of course possible, especially in the second group where the character of the plaster is radically affected by the degree of calcination, and four sub-groups are distinguished, namely, lightly burnt, moderately burnt, hard burnt and anhydrite proper.

The hemi-hydrate group exhibits the property of setting in a few minutes on mixing with water, though this action may be delayed by the addition of small quantities of keratin or similar glue-like materials, in which case the plasters are known as " retarded " plasters.

The anhydrous group, whether derived from gypsum or anhydrite, show no setting or hardening action within a reasonable time, unless " accelerators " such as potassium sulphate, alum, zinc sulphate, etc., are added in small quantities. The setting action differs from that of the hemi-hydrate type of plasters in being slow and continuous.

All the gypsum plasters are white when prepared from reasonably pure material, though small amounts of impurities may impart a pink or grey colouration which, however, does not detract from the quality of the plaster. Setting is a chemical action due to the reformation of hydrated calcium sulphate ($CaSO_4.2H_2O$) which crystallises. The crystals interlock and thus give strength, and the mass expands slightly, thus tending to minimise cracking. The final hardness of work done with calcium sulphate plasters is much greater than is the case with lime plasters, and in general the anhydrous types are harder than the hemi-hydrate types. Gypsum plasters, however, are unsuitable for outdoor work, being water soluble ; they also tend to corrode unprotected iron and steel work.

Magnesium Compounds from Bitterns and Sea Water.—Although magnesium is one of the most widely distributed metals of the earth's crust it does not occur naturally and the difficulty and expense of producing the metal from magnesium minerals have, until recent years, strictly limited its use as a constructional metal. The principal magnesium mineral is magnesite and the most successful processes for the production of the metal on an industrial scale yet devised employ this mineral as the initial raw material. In the United Kingdom, however, domestic supplies of magnesite are lacking and a considerable amount of research has been applied to the development of processes employing dolomite, which occurs in considerable quantity. In this connection it is reported that an important British company manufacturing metallic magnesium intends to adopt a process in the near future using local dolomite in preference to imported magnesite.

In other parts of the world also work has been proceeding on methods of manufacturing magnesium from compounds other than magnesite, and in California an effort is being made to use bitterns and sea water as the source of the metal.

These raw materials are at present being actively worked as sources of magnesium compounds, and the processes employed are described in an article entitled " Magnesium Metal and Compounds," by P. D. V. Manning, in *Chemical and Metallurgical Engineering*, September 1938, pp. 478-482.

The bittern process has been developed at Newark, California, where a large new magnesia plant has recently been erected. The evaporation of salt water in the San Francisco region is seasonal and therefore the bittern is run into large storage vats from which it can be drawn when required. Bromine, calcium sulphate and magnesium hydroxide are recovered, the bromine recovery stage being included only when required.

In practice the bittern, either raw or after the extraction of bromine, is mixed with calcium chloride from another part of the process to form calcium sulphate and magnesium chloride. The calcium sulphate and mother liquor pass to thickeners and then filters for the removal of the sulphate. The magnesium chloride liquor is next treated with lime which is mixed first with a small quantity of the liquor in a primary reactor, the mixture then passing into a secondary reactor where it meets the main body of the liquor. Magnesium hydroxide is precipitated and the slurry discharges into a thickener, the overflow, which is mainly calcium chloride solution, being returned to the earlier part of the process.

The hydroxide is washed and allowed to settle. After filtration the resulting cake of magnesia is calcined, cooled and taken to storage silos. The capacity of the plant is approximately 60 tons per day, including all magnesium products.

The lime used in the process is made from oyster shells dredged from San Francisco Bay. The shells are washed thoroughly before calcining and the plant capacity is 100 tons of lime per day.

On the other side of San Francisco Bay is the sea-water plant which has also recently been extended and improved. Here brine is pumped to a vertical mixer and a small amount of milk of lime added to remove bicarbonate and clarify the brine. The liquid then passes through a sand filter to a thickener where it is mixed with a lime slurry. The magnesium hydroxide formed is washed and taken to storage.

The hydroxide forms the starting point for the manufacture of a number of magnesium compounds. Dry hydroxide powder and hydroxide paste are easily prepared. If carbonates are required the slurry is treated with scrubbed boiler flue gases, boiled, filtered and dried. Magnesium oxide is made by calcining the carbonate. The capacity of the plant is now about 40 tons daily in terms of basic carbonate and the products marketed include fine-grade pharmaceutical and chemical materials, various grades of carbonates, hydroxides and oxides, milk of magnesia and hydroxide pastes.

Synthetic Water Softeners.—In the recently issued Report of the Chemical Research Board, Department of Scientific and Industrial Research, for the triennial period ended December 31, 1937, are records of investigations carried out with several unusual water-softening materials, namely, treated clays and fuller's earth, ulmin derivatives and synthetic resins.

The results achieved in preparing base-exchange materials from clays and the preparation of ion-exchange materials from lignite and other ulmin-rich material were dealt with in this BULLETIN, 1936, **34**, 90-91 and 1937, **35**, 90-92. More recently, condensations have been carried out on such ulmins with formaldehyde in alkaline solution, and the products exhibit an improved capacity for removing cations from solution and, in addition, show increased mechanical strength over the parent ulmins.

As the result of investigations carried out some years ago and described by B. A. Adams and E. L. Holmes in a paper, " Absorptive Properties of Synthetic Resins " (*J. Soc. Chem. Ind., Lond.*, 1935, **54**, 1T.), a base-exchange material of an entirely new type was discovered. It was found that insoluble condensation products of formaldehyde with certain phenolic substances possess the property of adsorbing cations from solution, a process resembling that of base-exchange, and in fact the polyphenolic products can be employed for softening hard water by removal of calcium and substitution of sodium. Subsequent work has shown that products having the desirable properties of hardness, infusibility, insolubility and brittleness can be obtained from polyhydric phenols and formaldehyde. Cheap products can be obtained by using natural polyhydric phenols such as the tannins of cutch, quebracho, gambier and larch bark, but when cheapness is not the first essential, products from resorcinol, phloroglucinol and other pure phenols may be used. It has been shown also that products from mixtures of phenols, including a monohydric phenol as one constituent, for example, *m*-cresol with quebracho tannin, possess higher adsorptive powers than would be anticipated from either of the ingredients separately.

Condensation products prepared from certain aromatic bases, of which *m*-phenylenediamine was the best, have been shown to possess the property of removing or exchanging anions, such as sulphate and chloride, from solution. By suitable arrangement water passed successively through beds of the phenolic (base-exchange) and basic (acid-exchange) resins can be freed almost entirely from dissolved solids. The removal of calcium sulphate from water serves to illustrate this. The water is first passed over a base-exchange material which has been regenerated with dilute hydrochloric acid.

In this way each calcium ion is exchanged for two hydrogen ions and dilute sulphuric acid leaves the bed of the material. This very dilute acid next passes through an acid-exchange material which has been previously regenerated by caustic soda. In exchange for each sulphate ion this material gives up two hydroxyl ions, so that an amount of water is formed equivalent to the calcium sulphate originally present. If sodium carbonate is used in regeneration instead of caustic soda, the treated water contains carbonic acid, removable by aeration or vacuum treatment. Each type of resin can be regenerated and used repeatedly.

The processes involved have been protected by British and foreign patents and licences have been taken out by firms in Great Britain and abroad.

Another base-exchange material was described by R. Riley at a meeting of the Technical Association of the (U.S.) Pulp and Paper Industry recently (*Chem. Tr. J.*, 1938, **103**, 293). It is prepared from coal by treatment with chemicals, which may include sulphuric acid or sulphur trioxide, and is washed, stabilised and screened. The product obtained is black, hard and granular and when regenerated with sodium chloride, functions as a sodium zeolite. Its exchange capacity is 5,000-8,000 grains of hardness removal per cubic foot, depending on the amount of salt used for regeneration. It is completely resistant to aggressive attack by waters of low *p*H and can be used to soften satisfactorily either hard or relatively soft waters. A granular bed offers little resistance to the flow of water and it can therefore handle high flow rates of 6 to 8 gallons per minute per sq. foot with little loss of head. Since the exchange reaction is very rapid, completely softened water is obtained when operating at these high flow rates.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

SOILS AND MANURES

Nigeria.—Mr. H. C. Doyne, Senior Agricultural Chemist, in his half-yearly report on the Chemical Section, Southern Provinces, for January to June 1938, gives the following summary of experiments on green manuring carried out at Moor Plantation, Ibadan.

The results show that for the last five years there appears to be no diminution or significant differences in the yields of the succeeding crop (early maize) where the green manure (Mucuna) is (A) buried green in November, (B) cut in November, allowed to dry and buried in February, (C) allowed to ripen and buried in February, (D) burnt in November, or (E) burnt in February, but that when (F) the leaves and stems of the green manure crop are removed in either November or February there is a significant drop in yields.

Composite samples have been taken each year from each plot since 1933. The results of the soil analysis show that there are no particular differences between treatments A, B and C, but that these treatments give a higher total nitrogen and nitrate content than any of the others. Conversely, treatments D and E (burning) result in a higher *p*H value, base saturation percentage and total exchangeable base and available phosphorus contents than treatments A, B, C and F. Treatment F shows the lowest amounts of nitrogen, nitrates, exchangeable bases, available phosphorus and total exchangeable capacity, while the *p*H value is similar to treatments A, B and C.

Seasonal changes between May and October show a temporary diminution in nitrates and nitrogen and available phosphorus (the latter greatest for treatments D and E and very slight for the others). There is also a slight tendency for the acidity to increase.

Taking the average figures for each year from 1933 to 1938 for all the treatments, there appears to be no diminution in nitrogen content and the total exchangeable capacity remains the same, possibly showing that there are no losses from erosion. All the plots, however, irrespective of the treatments, have increased in acidity, the increase being on the whole greatest for treatment F and least for treatments D and E.

INSECTICIDES

Derris

Malaya.—The following statements are taken from a half-yearly report on research work conducted by the Department of Agriculture, F.M.S. and S.S., for the period ending June 30, 1938.

Mr. B. Bunting, Senior Agriculturist, reports that the clonal investigations with derris have been continued with satisfactory results, but much more research will be necessary before any definite conclusions on this work can be drawn.

One plant of *Derris elliptica* Changi No. 3 grown at the Central Experiment Station, Serdang, showed an analysis of 15·25 per cent. rotenone and 32·74 per cent. ether extract at 15 months of age, which is the highest figure yet recorded by the Department. This plant belonged to a clone of which the average rotenone content at the same period of growth was 13·47 per cent. with an ether extract of 29·99 per cent.

The ratio of ether extract to rotenone content of the clone in question is high compared with that of *D. elliptica* Sarawak creeping, which is usually in the proportion of about 3 of ether extract to 1 of rotenone.

Mr. T. A. Buckley, Acting Senior Chemist, reports that the effect of fertilisers on the growth of *Derris malaccensis* var. *sarawakensis* and *D. elliptica* Sarawak creeping has been tested, using (*a*) calcium cyanamide, basic slag and sulphate of potash, (*b*) rock phosphate dust and slaked lime, (*c*) slaked lime. In the case of *D. malaccensis* an equally large increase in yield over the control resulted from each treatment, but in the case of *D. elliptica* no such advantage accrued. The percentages of rotenone and ether extract were scarcely affected, though there was a slight tendency for a decrease in toxic content to accompany increased growth of root.

A trial was made of the variation of the root of *D. malaccensis* with age. An examination was first made at 15 months and subsequently at 3 month intervals up to 30 months. During this period the average percentage of ether extract declined steadily from 25·0 per cent. to 19·8 per cent. The weight of root increased after 15 months to an unimportant extent and not at all after 24 months. The poor total yield of root perhaps rendered the trial inconclusive, but the evidence of various other experiments has pointed to a decline in toxic constituents after about 18 months and to only moderate increases in yield.

A number of derris clones have fallen due for examination at given stages of maturity. The parent plants were selected primarily for high toxic content of their roots, though yield of root was considered. In general it has been found that the vegetative progeny of a single parent plant growing side by side exhibit extremely wide variations in yield and very considerable variations in toxic content of root. On the average, nevertheless, the toxic content is similar to that of the parent, but the yields frequently are totally different. *D. elliptica* Sarawak creeping is the type capable of giving the highest yield and a good clone may easily produce an average of 1½ lb. of root per plant with 7 per cent. of rotenone and 23 per cent. of ether extract. *D. elliptica* Changi 3 is the type so far found to give maximum rotenone contents, but is apt to produce only 2 to 3 oz. of root per plant. Two of the clones have been found to produce an average of ½ lb. of root with a rotenone content of 12 per cent. and 29 per cent. ether extract. *D. malaccensis* var. *sarawakensis* is a type yielding a low proportion of rotenone but sometimes high ether extract, and enormously variable in yield of root. The plants of a clone are particularly variable. With this type, and indeed with the others also, one clone may do better on one soil than another, but with another clone the position may be reversed.

The question of methods of analysis of derris root has received much attention. Many parallel tests with different methods have been made and as a result the process of extraction with carbon tetrachloride in Soxhlets has been abandoned. Extraction with cold chloroform as a routine method has been adopted and it has been verified so far that the results fall little short of those obtained by extraction with hot chloroform and are as good as those obtained by extraction with hot ethylene dichloride or ethyl acetate. The investigation is still continuing.

Mr. G. H. Corbett, Senior Entomologist, states that feeding experiments with toxicarol precursor, using the cockroach *Periplaneta americana* as the test subject and cocoa powder as the bait, gave negative results, the insects refusing to feed on cocoa powder mixed with toxicarol precursor and dying of starvation.

Repetitions of earlier experiments on the asphyxiant properties of derris have been carried out. Fresh crushed roots of derris from three localities all proved to exert a lethal distance effect on larvæ of *Spodoptera pecten* Guen. The rotenone content, dry basis, of the roots used varied from 7·04 per cent. down to 0·34 per cent., but this did not appear to affect its killing power. Fresh water extract of derris roots gave negative results, as did pure rotenone and pure rotenone ground to a paste with water. Dry powdered root, rotenone 13·25 per cent., ether extract 30·2 per cent. (dry basis), also gave negative results, but when this powder was ground to a paste with water it exerted a similar action to fresh crushed roots, but slightly less rapidly. Controls to all these experiments gave negative results.

Spraying experiments with derris extracts have been temporarily discontinued owing to the inherent inaccuracies of the apparatus. Dusting has been tried with more success and one thousand larvæ of *Spodoptera pecten* have, so far, been dusted with fairly consistent results. The best dilution of dust appears to be 10 per cent. powdered derris and 90 per cent. talc. Results have been expressed as weight of dust projected and reduced to weight of derris powder in the mixture and plotted against percentage kill, this giving a more accurate picture.

BEVERAGES

Cacao

Malaya.—According to the report of Mr. B. Bunting, Senior Agriculturist, F.M.S. and S.S., for the half-year January to June 1938, small scale trials in connection with the cultivation of cacao at the Central Experiment Station, Serdang, have proved so successful that it has been decided to plant up a further 10 acres.

The preliminary trials with this crop, which was interplanted with *Gliricidia maculata* as shade, showed that several of the cacao trees reached the fruiting stage approximately three years from the date of planting in the field. At this stage the overhead shade was encouraged by pruning back the Gliricidia trees so as to form a complete canopy over the cacao.

Mr. Bunting adds that so far cacao has not been cultivated on a commercial scale in Malaya and that the results of further trials with this crop will be awaited with considerable interest.

Tea

Malaya.—Mr. B. Bunting, Senior Agriculturist, F.M.S. and S.S., in his report for the half-year January to June 1938, states that trials are being made at the Central Experiment Station, Serdang, in the manufacture of green tea and that a small cylindrical steaming machine has recently been acquired for this purpose. In the first instance this machine will be used in conjunction with the machinery normally employed for the production of black tea and if the results of these preliminary trials prove satisfactory it is proposed to improvise an inexpensive hot-air revolving cylindrical drum for drying the partially fermented leaf preparatory to firing. This is being compared with the old Chinese method of making what is known as " Oolong " tea, which is prepared by hand and fired either in baskets or shallow open iron pans.

According to the report of the mycologist for the same period, red-root disease, caused by the fungus *Ganoderma pseudoferreum*, appears to be the commonest root disease of lowland tea in Malaya. Infection originates mainly in jungle stumps or stumps of Albizzia, Glyricidia or Grevillea shade trees and also spreads to the tea bushes by contact of the tea roots with roots of growing, diseased shade trees. Affected tea bushes wilt suddenly when the mycelium of the fungus reaches and encircles the collar. Shade trees, when attacked, usually begin to show signs of die-back in the branches some months before they are killed, thus giving an early indication of the need for examination of the roots of adjacent tea bushes and isolation of the infected area of soil.

The fungus *Ustulina zonata* is also a fairly common cause of root disease of both highland and lowland tea. The disease usually spreads from infected jungle stumps or stumps of felled shade trees. In some cases a stump may be infected with both *U. zonata* and *G. pseudoferreum*.

Cereals

Guinea Corn

Nigeria.—Mr. W. E. Freeman, Agricultural Botanist, Northern Provinces, in his half-yearly report for January to June 1938, gives the following results of variety trials with Guinea corn carried out at Samaru ; Faulkner's strip method was employed in the trials.

Average yield of 32 plots New Local Mixture=755·7 lb. per acre
,, difference of 6 plots Old ,, ,, =+ 68±52·4
,, ,, ,, ,, Tadalisi =+181±52·4
,, ,, ,, ,, Shotta =+296±52·4
,, ,, ,, ,, Dikko =+ 34±52·4
,, ,, ,, ,, F18 =+175±52·4

All the selected strains did well, the yields of Tadalisi, Shotta and F18 being significantly greater than the new standard. F18 is a fairly new selection which is still very heterozygous.

Rice

Malaya.—Mr. G. H. Corbett, Senior Entomologist, Department of Agriculture, F.M.S. and S.S., in his report for the half-year January to June 1938, states that the cage experiments with rice borers, referred to in the previous report (this Bulletin, 1938, **36**, 229), were completed in Malacca. Six cages, 6 ft. × 6 ft. × 7 ft., of timber and mosquito wire gauze, each with a door, were planted with the same variety of padi. Newly hatched larvæ of *Schoenobius* were liberated at intervals in three of the cages, the total number of larvæ per cage being 967. The other cages were not colonised and were intended as controls. The cages cut out about 50 per cent. of light as measured by a selenium cell. For comparative purposes three plots of the same variety of padi were shaded with palm leaves, the light reduction being about 70 per cent.

It was found that stem-borer larvæ penetrated the control cages so that no useful results were obtained in this direction. The padi grown under shade was heavily attacked by rats and borers and little crop was obtained.

There was no constant difference in height of plants within and without the cages.

At Serdang two sets of sowings are being carried out at monthly intervals, from one of which egg-masses of borers are hand collected and any parasites emerging therefrom are liberated back into the plots whence they came, while the other series is undisturbed except for a record of the number of egg-masses found.

The object is to ascertain : (1) whether plants can be kept moderately free from borers by collection of egg-masses and

(2) whether egg-parasites fluctuate in a similar manner to their hosts. The results to date suggest that the answer to (1) is in the negative.

A second series of tanks was also started at Serdang. This consists of a number of tanks completely enclosed in muslin cages. The muslin of certain tanks is lifted after sunset and lowered again just before dawn, thus exposing the padi during the period of activity of the moths and allowing natural infestation by borers, and also obviating the differences due to light. Certain cages are permanently closed for comparison. Into other permanently closed cages borer ova are introduced, thereby inducing borer damage to padi.

SUGAR

Cane

Antigua.—A report on the work conducted by the Department of Agriculture during the half-year January to June 1938, states that during the period under review the following experiments were reaped:

Varietal	Experiments—	Plant Canes	3
,,	,,	1st Ratoons	4
Manurial	,,	Plant Canes	6
,,	,,	1st Ratoons	7
,,	,,	2nd Ratoons	3

The results obtained on reaping these experiments have been submitted to Mr. P. E. Turner, Adviser in Sugar Cane Experiments to the Commissioner of Agriculture, for statistical analysis and will not be available for publication until these analyses have been completed.

During the period one experiment was planted with Ba 11569 (crop plants) to compare the manurial value of the three different grades of Niciphos with that of equivalent mixtures of sulphate of ammonia and superphosphate, both in the presence and in the absence of potash. This experiment will be reaped in 1939.

FRUITS

Citrus

Malaya.—The report of the Mycologist, Department of Agriculture, F.M.S. and S.S., for the half-year January to June 1938, records that a bark rot of the Mediterranean sweet orange which results in the death of affected branches, was found to be associated with a fungus, *Nectria* (*coccicola* ?), which produces fructifications on the epidermis of the decayed bark. Isolations from diseased tissue yielded a *Fusarium* sp. which later formed the perfect Nectria-stage in culture.

Inoculations with conidia and perithecia have given no result to date. Affected branches were treated successfully by excising the decayed tissue and painting with a disinfectant.

Pineapples

Malaya.—Mr. G. H. Corbett, Senior Entomologist, Department of Agriculture, F.M.S. and S.S., in his report for the half-year January to June 1938, states that an investigation to ascertain whether the mealy bug, *Pseudococcus brevipes* Ckll., induces a wilt in pineapples has been inaugurated. It may be mentioned that the populations of *P. brevipes* on plants in Malaya are apparently not so large as in Hawaii and that they are generally situated at the base of the outside leaves in Malaya and not congregated at the central leaves as in Hawaii.

SPICES

Nutmeg

Malaya.—The report of the Mycologist, Department of Agriculture, F.M.S. and S.S., for the half-year January to June, 1938, records that a disease of the fruits of nutmeg, characterised by the development of lesions on the epidermis, splitting and premature fruit fall, is associated with the fungus *Coryneum myristicae.* About 50 per cent. of the fruits in two areas were lost from this disease in May and June.

OIL SEEDS

Ground-nuts

Nigeria.—Mr. W. E. Freeman, Agricultural Botanist, Northern Provinces, in his report for the half-year January to June 1938, states that strain T, which was mentioned in the last report as giving promising results (this BULLETIN, 1938, **36**, 234) has now been distributed to farmers under the name of "Samaru 38." It is at present being confined to a small village area near Samaru in which an effort is being made to ensure that it is not mixed with the local nut. The results from a small trial at Samaru were not significant, but two strains from T were best, each giving yields of 109 per cent. of standard.

At Kano the results from a large-scale yield trial were:

	Yield of kernels per acre.	Percentage of standard.
	lb.	
Strain 8	1,109	114
Castle Cary	1,074	110
Strain 10	1,044	107
Duke of Samaru	977	100
Standard	973	100

The trial was significant at the level of P = 1 per cent. A difference between any two strains of 4·5 per cent. of standard was significant.

The results of a smaller yield trial were also significant and two strains with yields of 116 and 111 per cent. of standard respectively were significantly better than the latter.

During the last three years the yield of "strain 8" has been 139, 111 and 114 per cent. of standard respectively. In each year the increase has been significant and strain 8 was always the heaviest yielding strain in the trial. It is intended to distribute it to farmers next year under the name of "Kano 38."

Oil Palm

Malaya.—According to Mr. T. A. Buckley, Acting Senior Chemist, Department of Agriculture, F.M.S. and S.S., in his report for the half-year January to June 1938, there is a small but increasing demand for palm oil, particularly that fraction which is permanently liquid at a tropical temperature, for medicinal or dietetic purposes. The active constituent is carotene, and preliminary steps have been made towards producing a more deeply pigmented oil than the local commercial article. The oil produced on Malayan estates is fairly uniform in colour, as nearly all have been planted with one species of palm, the Deli type. A number of West African varieties of oil palm growing at Serdang have been tested and although generally the darkest oil is derived from species with fruit of thinnest pericarp, a number of palms have been selected on which a reasonable thickness of fruit pericarp is combined with an intensity of colour of oil several times greater than that of estate palm oil. It is proposed to produce seed from these either by self-fertilisation or controlled crossing, after which the next step will be to find whether the progeny will produce fruit of the desired type.

It has been found that carotene can be recovered from fuller's earth which has been used to bleach palm oil.

FIBRES

Manila Hemp

Malaya.—According to the report of Mr. B. Bunting, Senior Agriculturist, F.M.S. and S.S., for the half-year January to June 1938, small scale varietal and manurial trials with Manila hemp are now being undertaken by the Department in order to ascertain its suitability or otherwise for local cultivation.

A number of small plots have also been established in different parts of the country under varying soil conditions with a view to collecting information as to the most suitable soils for its cultivation either on a small or large scale.

The Department has recently introduced a small decorticating machine specially designed for stripping Manila hemp and trials are now being conducted at the Central Experiment Station, Serdang, in the production of the fibre.

MINERAL RESOURCES

BRITISH GUIANA

The Imperial Institute has received from the Commissioner of Lands and Mines the following report by the Director on the work carried out by the Geological Survey during the six months ended June 30, 1938.

Geological Surveys

The geological survey of the North-West District was continued during the first half of 1938. Mr. S. Bracewell examined the area between Tassawini and Arakaka, Mr. D. W. Bishopp the area adjacent to the Barama River above Towakaima, and Dr. Bryn Davies the lower Barama District.

The main structural features of the area correspond with those observed in the Cuyuni District. In the latter area it has been observed that whilst in the east the main structures run north-easterly, in the west they conform to the north-westerly trends observed in the Mazaruni and to the axis of the Pakaraima Mountains. A corresponding change is evident in the Barama River area ; a pronounced north-easterly trend is brought out by the detailed mapping of the manganiferous and quartzitic horizons and sheared volcanic rocks in the eastern portion of the area ; further west the structural lines run east-west and in the upper portion of the Barama River they run north-westerly.

It is hoped to complete the examination of the North-West District during the second half of the year.

The following Geological Survey reports have recently been printed :

Bulletin 6.—(1) Report on Groete Creek-Mariwa Goldfields.
(2) Manganese Deposits at Saxacalli.

Bulletin 7.—Reconnaissance Survey of Part of North-West District.

Bulletin 9.—Report on Quartzstone Head, Aremu Mine, and Puruni River near Peter's Mine.

Mineral Exports

		1936.	1937.	1938 1st half year.
Gold	*oz*	35,857	39 047	18,326
Bauxite . . .	*tons*	170,153	300,707	177,018
Diamonds . .	*carats*	42,479	34,556	16,434

Mining Developments

The above figures serve to indicate the general trend of mineral production in the colony. The rapid expansion in bauxite production is due to the greatly increased demand for this mineral. The ore is at present being obtained solely from the workings of the Demerara Bauxite Company situated a few miles above Mackenzie on the Demerara River. Two other companies are prospecting bauxite occurrences in the Berbice and Essequibo Districts.

The two dredges owned by the British Guiana Consolidated Gold Fields Co. are working satisfactorily in the Mahdia River (Potaro District); during the first seven months of 1938, according to recorded entries at the Department of Lands and Mines, the new dredge working in the lower Mahdia produced approximately 2,455 oz. and the old dredge 986 oz. of gold bullion. A recent statement issued by the company indicates that the average recovery of gold over a period of eight months was 2·49 grains per cu. yd. in the lower portions and 3·26 grains per cu. yd. in the upper portions of the Mahdia River. The same report states that " it has been decided to accelerate the prospecting programme on the Konawaruk River, in which area scout drilling over four miles indicates 14,750,000 cu. yd. averaging 3·4 grains."

Engineers of the N.A. Timmins Corporation of Canada are at present testing the Oko and Aremu Rivers (Cuyuni River) with a view to dredging; the same company is making an examination of the old Aremu Mine. Mining prospections are being carried out by the Solar Development Co. of Canada at Aurora on the right bank of the Cuyuni River below Devil's Hole Rapids.

The Central Mining and Investment Corporation have recently applied for Petroleum Exploration Permits over the northern portion of the Colony. It is understood that recent developments in adjacent portions of Venezuela may have led to this revival of interest in the petroleum possibilities of the Colony.

NIGERIA

The Imperial Institute has received the following statement from the Director regarding the work carried out by the Geological Survey during the period January to June 1938.

Gold.—In the dry season the survey of the goldfield was continued but has now been suspended for the purpose of recording and summarising present-day geological information with respect to it. It is hoped to publish this information next year.

Recent developments on the goldfield indicate an extension in a southerly direction across the River Niger to Kabba and Ilorin Provinces. Little is known of the detailed geology of this area, which is to the south of that surveyed. It is too early to give an opinion on this occurrence which at the moment is attracting a great deal of labour from other parts of the field. The output for the half-year was 12,169·52 oz.

Geology—Sokoto Province.—The investigation and mapping of the sedimentary rocks of Sokoto Province, which had been suspended for some years, was resumed and considerable progress was made. The chief problem in this area was the identification of a thick set of unfossiliferous sandstones and clays known as the Gundmi Series, which occupies over 5,000 sq. miles of the Province. The unfavourable exposures of the strata and the absence of fossils have hitherto prevented a definitive conclusion as to the age of this series, but as a result of geological reconnaissance during the years 1928 and 1929 it was considered probable on lithological grounds that the series was of Middle or Upper Eocene age. The investigations this year have been greatly assisted by the recorded sections of the wells constructed by the Department in the Province during the last decade. During this past six months it has been shown that the Gundmi Series is Cretaceous, since it has been found to pass beneath a band of shales containing vertebrate and invertebrate fossils of Maestrichtian : Danian (Upper Cretaceous) age. The Gundmi Series crosses the international boundary into French Niger Colony and the French geologists agree in assigning the beds to the Cretaceous.

Water Supply: *Wells.*—Well sinking has been continued in Sokoto, Katsina, Kano, Bauchi, Bornu, Benin and Owerri Provinces. Construction has been extended to additional Divisions (Gombe Division and Aba Division) in Bauchi and Owerri Provinces respectively and to Zaria Province. In addition, a programme of well-top construction is being carried out on sound, native-dug wells in Daura Emirate of Katsina Province to reduce the incidence of water-borne disease.

The work in Zaria Province is in connection with the Sleeping Sickness Settlement campaign in the Anchau District. The programme in Benin Province has been completed for the present. All sinking has been through sedimentary rocks, in which no unusual difficulties were encountered, save in some localities in Katsina Province underlain by a crystalline complex.

Drilling.—Drilling has been continued at Nguru, in Bornu Province, for the Nigerian Railway. One well has yielded 1,800 gallons per hour on test and a second well 5,000 gallons per hour.

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PLANT AND ANIMAL PRODUCTS

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IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 4

(July to September 1938)

Prepared in collaboration with the Imperial Institute of Entomology and the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

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Effect of Addition of Oil on the Toxicity to Plant Bugs of Derris and other Insecticides. By R. A. Fulton and N. F. Howard. *J. Econ. Ent.*, 1938, **31**, No. 3, 405-410. Includes experiments with pyrethrum.

The Control of the Apple-blossom Weevil. By M. Hanf. *Amer. Chem. Abstr.*, 1938, **32**, No. 14, 5570. Abstr. of article in *Kranke Pflanze*, 1938, **15**, 41-46. Includes account of the use of pyrethrum.

Experiments in the Control of Green Apple Bug, Apple Redbug, and the Pale Apple Leafhopper by means of Pyrethrum Dusts and Sprays. By N. A. Patterson. *Rept. Ent. Soc. Ontario*, 1937, **68**, 18-19. (*R.A.E.*, 1938, **26**, A, Pt. 9, 534.)

Blattlaus-Bekämpfungsversuche auf dem Hopfenversuchsgut Hüll, 1937. (Experiments in combating aphids in 1937 at the Hop Experiment Station at Hull.) By H. Hampp and J. Jehl. *Nachrbl. Dtsch. Pflanzenschutzdienst.*, 1938, **18**, No. 5, 43-45. (*R.A.E.*, 1938, **26**, A, Pt. 9, 523.) A report of successful trials with derris-pyrethrum sprays.

Insects and Allied Parasites Injurious to Livestock and Poultry in Canada. By E. Hearle. *Publ.* 604, *Dep. Agric. Canada.* Includes references to the use of pyrethrum.

An Attempt to Control Malaria by the Destruction of Adult Mosquitoes with Insecticidal Sprays. By G. Covell, H. W. Mulligan and M. K. Afridi. *J. Malar. Inst. India,* 1938, **1**, No. 1, 105-113. (*R. A.E.*, 1938, **26**, B, Pt. 9, 180.) Tests with pyrethrum sprays.

Carpet Beetles. By E. A. Back. *Leafl. No.* 150, *U.S. Dep. Agric.* (*R. A.E.*, 1928, **26**, A, Pt. 7, 400.) Brief account of control with pyrethrum-oil sprays.

Pyrethrum Production Growing—Brazil. *World Trade Notes, U.S. Dep. Comm.*, 1938, **12**, No. 35, 592.

Japanese Pyrethrum Report. *Chem. and Drug.*, 1938, **129**, No. 3051, 111. Gives information of the estimated production, quality, and price trend.

Pyrethrum—A Long-range View of Production and Markets in Japan. By H. Leopold. *Soap,* 1938, **14**, No. 9, 86-89, 105, 107.

Pyrethrum Exports—Japan. *World Trade Notes, U.S. Dep. Comm.*, 1938, **12**, No. 27, 467. Gives figures for 1935, 1936, and 1937.

Pyrethrum Export Guild to be Formed Soon—Japan. *World Trade Notes, U.S. Dep. Comm.*, 1938, **12**, No. 37, 632.

Pyrethrum Imports Decline—United States. *World Trade Notes, U.S. Dep. Comm.*, 1938, **12**, No. 28, 481. Figures of imports for the first four months of 1938 and includes imports from Brazil.

OTHER INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

Une Rubiacée du Gabon qui Sert à Narcotiser le Poisson. By F. Pellegrin. *Rev. Bot. Appl.*, 1938, **18**, No. 203, 498-501. Description of *Randia walkeri* Pellegrin sp. n., used as a fish poison.

Soybean Flour as a Spray Material. By M. D. Farrar and W. P. Flint. *J. Econ. Ent.*, 1938, **31**, No. 4, 482-485. Its use for imparting certain spreading and sticking properties to sprays.

NOTE.—The reference in brackets—*R. A.E.*, etc.—which appears after certain items of the bibliography indicates the part and page of the *Review of Applied Entomology* in which an abstract of the publication mentioned can be found.

NOTICES OF RECENT LITERATURE

Books for review should be addressed to " The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

OVERSEAS TRADE AND EXPORT PRACTICE. By G. T. MacEwan, M.I.Ex. Pp. xvi + 366, 8½ × 5½. (London: Macdonald & Evans, 1938.) Price 12*s*. 6*d*.

The author of this book is the Vice-Chairman of the Institute of Export, and the book has been written to cover the syllabus adopted by the Institute with a view to providing students entering upon an export career with knowledge and understanding as a background to their practical activities in the conduct of export business.

The book is not concerned with detailed export practice but deals with the main functions and organisation of overseas trade. The author starts with a review of international trade and the restrictions on such trade, and goes on to discuss world commerce in raw materials and manufactured products. Methods of marketing these products are dealt with fully. Other chapters deal with Transportation, Industrial Combination, Government and Other Services to Exporters, Financing Overseas Trade, Publicity in Export Trade and Trade Marks.

Each chapter is full of valuable, practical information, in particular those on Financing Overseas Trade and Publicity in Export Trade. In the latter chapter pp. 336 to 339 alone should serve to impress upon exporters the vital need for a detailed study of any overseas market if advertising methods are to be successful.

The author writes in an interesting style and is to be congratulated on this book, which admirably achieves its object. It should be invaluable, not only to students, but to all business men who wish to understand some of the complex problems of international trade.

THE PRINCIPLES OF SOIL SCIENCE. By Alexius A. J. de Sigmond, Ph.D. Translated from the Hungarian by Arthur B. Yolland, B.A., Ph.D. Translation edited by G. V. Jacks, M.A., B.Sc. Pp. xiv + 362, $9\frac{1}{4} \times 6\frac{1}{4}$. (London: Thomas Murby & Co., 1938.) Price *22s. 6d.*

Professor de Sigmond has been known internationally for many years as an expert on soils, but his special connection with and great knowledge of one particular branch—the reclamation of alkali soils—has led to his name being associated by English-speaking people chiefly with this one subject. The fact that his studies and experience cover the whole range of soil science has to some extent been overlooked.

The present book was originally published in a longer form in Hungarian, a language in which its accessibility to other workers is very restricted. The aim of the original volume was to give a complete outline of the present state of pedology. As there is a considerable volume of recent work published in English dealing with soil physics and soil microbiology, these sections have been omitted in the English version as well as details which are of purely local interest or which have been considered fully in other English works. The main theme of the book is the presentation and discussion of the system of soil classification which is already known internationally by the author's name, but has not been described before in an English publication. The book is therefore concerned with the study of the soil itself and not with its practical applications in agriculture.

The introduction outlines the author's ideas of the scope of soil science. He describes soil as " a discrete natural product differing from both the dead mineral world and the living organic world, lying on the boundaries of the lithosphere and the biosphere and connected with both, uniting them and obtaining its raw materials from them ; it is the product of special genetic factors which determine and continuously direct the physical, chemical and biological phenomena and charactertistic properties of the soils, thus making them the cradle of continuous organic life and the burial-place of dead organic matter." The soil is therefore the scene of constant changes and transformations, and must be regarded as a dynamic system, in contrast to the static system represented by rocks and minerals, and this recognition of the dynamic nature of the soil is an outstanding feature of modern soil science. To understand the true character of such a dynamic system, not only its present state but its past history must be studied, and at least an attempt made to forecast its future development.

The study of soil genetics, therefore, forms the first step to a full understanding of the soil. This includes the study of the raw materials from which the soil is derived, of the numerous factors converting these raw materials into soil and of the processes which lead to the production of distinct soil types according to the conditions under which soil formation takes place. The first stage in the formation of a soil is the disintegration of solid rock by weathering, either of a chemical or physical nature. The character of the soil formed therefore depends in the first place on the composition of the original rock, as well as upon the action of the numerous factors—climate, topographical and hydrological conditions, vegetation, effect of micro-organisms and of animals and influence of man through his agricultural activities—which affect the weathering process. Since the relative value of all these factors varies with different soils, there is scope for the production of an enormous number of kinds of soil.

All this, however, which embraces what may be called the soil's past history, is naturally in most cases uncertain and open to doubt. The characters of soil types must be determined by direct observation and may be divided into four groups, those revealed by field studies and physical, chemical and biological characteristics. As stated above, the author has omitted the original sections on soil physics and soil microbiology and deals only with the chemical characteristics of soils and, briefly, with soil surveying in the field. The former form the main basis of his general classification of soils. He does not describe actual methods of examination of soils, but explains what may be deduced from the results of analyses and how they may be utilised for characterising different soils. The chemical characteristics of soils may be conveniently divided into several groups, comprising the mineral-chemical composition, the composition of the organic matter, the characteristics of the absorption complex of the soil, the colloidal explanation of adsorption phenomena and coagulation, and the nature of the water extract of the soil. All these factors are used to varying degrees as a basis for the chemical characterisation of soils.

There have been numerous attempts made at different times, particularly by Russian and American workers, to find a basis for the classification of soils. None of these can be regarded as entirely satisfactory and the author has therefore devised a system based on the results of leaching experiments, that is, mainly on chemical characteristics. All soils are first classified into three main groups according to the nature of their parent materials, namely, organic soils, organic and mineral soils and purely mineral soils, the second group being naturally the largest. Each group comprises a small number of sub-groups, the first being divided into raw organic soils, such as turfy soils, and humified organic soils, such as peats. The second group includes as sub-groups raw organic-mineral soils, humic siallites, ferric siallites and allites, while the third main group is divided into raw mineral soils, mineral soils with some decomposition and mineral soils with the end-products of decomposition. Each sub-group is further divided into a number of " soil orders." Each " order " includes one or more main types, together with a number of sub-types. Local varieties are then distinguished according to physical characters and to their content of plant nutrients. The author has drawn up a scheme, submitted to the Third International Congress of Soil Science at Oxford in 1935, but not published in the present book, by which the position of each soil in this classification can be determined.

The final section, on the principles of soil cartography, includes a consideration of the various types of soil maps, depending on the use for which they are intended, and the reasons for the geographical distribution of the different soil types. There is an excellent discussion on the agreement found between the actual distribution of soil types and the author's scheme of classification.

Throughout the book the author discusses the contributions to the knowledge and theory of soil science made by other workers all over the world.

Every reader will not agree entirely with all the details of the author's system of soil classification. Nevertheless, his comprehensive system based essentially on the chemical characteristics of the soil, although not intended to be final, satisfactorily fills many gaps in other systems and represents a considerable step forward towards a universal classification based on strictly scientific principles. It forms one of the most valuable additions to the literature of soil science made during recent years in the English language.

THE STUDY OF THE SOIL IN THE FIELD. By G. R. Clarke, B.Sc., M.A. Second Edition. Pp. 192, 6¾ × 4½. (Oxford: The Clarendon Press, 1938.) Price 6*s*.

The first edition of this book has already been noticed in this BULLETIN (1937, **35**, 133). The appearance of a second edition within two years therefore indicates its good reception.

The new edition in the main follows the same lines as before, but a good deal of new material has been incorporated. Information on methods of sampling soils other than by means of monoliths is now included, and the English method of mapping by series is described in sufficient detail to enable the reader to interpret English soil maps and memoirs. The section on soil structure has been enlarged by the inclusion of a new system of nomenclature devised by the author.

The book should continue to fill a useful place in the modern soil science library.

THE SOILS OF PALESTINE. By A. Reifenberg, Ph.D., Dipl.Agric. Translated by C. L. Whittles, M.A., Ph.D. Pp. viii + 131, 8½ × 5½. (London: Thomas Murby & Co., 1938.) Price 14*s*.

Palestine as the original home of the Jewish race was traditionally a land flowing with milk and honey. For hundreds of years, however, the land has been allowed to deteriorate steadily, terrace cultivation on the hillsides being abandoned and trees cut down, with the consequence that soil erosion has been widespread and severe. The ancient irrigation works have been destroyed or allowed to fall into ruin, and dung has been burned as fuel, with the result that the soil has become more and more impoverished.

Since the increased Jewish population of recent years depends primarily for its existence upon agriculture, the investigation of the soils of the country, their improvement and successful utilisation, becomes a task of considerable importance. Full use must also be made of comparisons of the soils with those of similar types in other countries, so that knowledge gained elsewhere may be applied and mistakes avoided.

The author of this book has been working on the soil problems of Palestine for some thirteen years, and although he realises that many years must elapse before these problems approach solution, he has brought together a large amount of the information so far collected.

The book is divided into five main sections and starts with a short general account of the geology and relief, moisture conditions and climate of the country. This is followed by a long section on soil formation in Palestine, tracing the evolution from the parent rock (chiefly limestone) of the various typical soils now in existence, under the influence of the Mediterranean type of weathering. The weathering process in general is considered, with special emphasis on the rôle of percolating waters and of colloidal silicic acid. The author gives a detailed description of the different types of soil found, classified under the climatic regions, varying from arid to humid, in which they occur.

The third section compares soil formation under the Mediterranean type of weathering, as exemplified in Palestine, with that occurring under other climates, with particular reference to soils derived from calcareous parent materials. The effects of the different types of weathering and climatic conditions on the composition of the clay fraction and of the base-exchange complex, and on the hydrogen-ion concentration are also dealt with.

In view of the economic importance of citrus cultivation in Palestine—oranges and grapefruit being the principal exports, their value exceeding the total of that of all other crops—the section on the agricultural aspect of the study of the soils is devoted almost exclusively to consideration of the problems arising from the utilisation of different soils and districts for these crops. The choice of soils for citrus cultivation, the importance of adequate drainage, the harmful effects of " hard pan " or of an impervious sub-soil at a shallow depth in the soil, the dangers due to large amounts of soluble chlorides which may be present in irrigation water such as that of the Jordan, and the manuring of citrus trees on the different types of soil, are all considered.

The final section gives a short history of Zionist colonisation in Palestine, which, it is not generally realised, started as long ago as 1878, followed by a discussion of the natural conditions in regard to agricultural settlements, the possibilities of improved and perhaps intensified agricultural production and the estimated absorptive capacity of the country for further immigrants.

Each section is provided with a good bibliography.

The book as a whole gives a good picture of soil conditions and problems in Palestine and of the improvements in agricultural methods and results brought about under the auspices of the Jewish Nationalist organisations.

The translator's share of the work has been very well done, as the book can be read without the fact that it was originally written in another language being at all evident.

BEVERAGE MANUFACTURE (NON-ALCOHOLIC). By R. Harold Morgan, M.Sc. Edited by A. T. E. Binsted. Pp. 240, 8½ × 5½. (London : Messrs. Attwood & Co., Ltd., 1938.) Price 30s.

The author states that the aim of this book is to provide sufficient basic information "to enable the manufacturer himself to build up his own distinctive beverage of whatever type he may desire." At the same time it is intended that it should also be of benefit to the less experienced members of the trade. In presenting the information with these objects in view the author has laid special emphasis on the importance of up-to-date scientific methods and strict control of factory practice.

While welcoming this addition to the somewhat scant literature on the subject published in this country, one cannot but feel that the author has to some extent failed fully to achieve his aims. The knowledgeable manufacturer will look to a book of this kind as a means of leading his thoughts in the direction of how he can improve upon his product. To attain this he must have available particulars of the more important research and recent developments in the industry. The author has touched only lightly upon such matters and has failed to indicate where further information on the subject may be obtained. There is a mass of information scattered throughout the technical journals, particularly those of the United States and Germany, and the addition of a comprehensive bibliography, while increasing but little the size of the book, would have considerably enhanced its value. Brief reference is made to the manufacture of fruit juices, but some reference to sources of information regarding recent investigations, both in this country and abroad, on improving the quality of this essential raw material would have been appreciated by the progressive manufacturer who is always interested in the methods of manufacture of his raw materials, even though such knowledge may not be essential to him. Again, on the mechanical side of the beverage industry, the recent foreign developments in sterile bottling are undoubtedly of interest, but the manufacturer who wishes to make a thorough study of the subject is given no guidance. The provision of a bibliography would also have been of considerable value to the less experienced members of the industry as indicating lines along which further studies might be pursued.

The book is arranged in two parts; the first relates to the technical and scientific side and treats with such matters as syrup making, preservatives, colours, flavours, carbonation and the various types of beverages, etc. The second part deals with some of the modern types of machinery and equipment required by bottlers. The selection of the makes of machinery described appears, however, to be somewhat arbitrary as there are products of other manufacturers which might with equal justification claim a place in this section. To each section is appended a "buyers' guide," comprising in all over 40 pages of advertisements.

There is an "Index and Glossary" at the end of the book, but unfortunately this gives only the number of the chapter in which the subject is dealt with and not the page reference. True it serves as an alphabetical list of the Contents, but the primary object of an index, which is to facilitate rapid reference to a subject, is defeated.

There is no doubt that even in its present form the beverage industry will find this publication of value, although we are afraid its price will be beyond the means of many of the younger members. It is hoped, however, that in any future edition attention will be given to the several matters which at present detract from its usefulness.

CANE SUGAR PRODUCTION, 1912-1937. By H. C. Prinsen Geerligs, Ph.D. and R. J. Prinsen Geerligs. Pp. xi + 164, 9¾ × 7. (London: Norman Rodger, 1938.) Price 10*s*.

Dr. H. C. Prinsen Geerligs has worked over fifty years in the interests of the cane sugar industry, and for the last twenty-five years he has carefully noted down all that has happened in the province of cane sugar production and distribution. These notes have been embodied in this book by Dr. Geerligs and his son, together with statistics of production, exports, consumption, etc., for the years with which the book deals.

The book is divided into two parts. Part I deals with the economic history of the years 1912 to 1938 in respect of sugar, and chapters are devoted to the measures taken by the Allied and associated Powers to keep themselves supplied with sugar during the War, and the efforts made by the various countries to deal with the slump in sugar prices which followed it.

Part II deals with the sugar-cane industry in different countries of the world, and after an account of the industry in each country, figures of production, exports and imports are given.

The information given in the book is concise and arranged so that the whole sugar position for any particular country in recent years can be seen at a glance. It is to be regretted, however, that more care has not been given to keeping the units uniform or stating their nature with more precision. Most of the figures of quantities are given in "tons," but occasionally "metric tons" are used and sometimes "cwts." or "piculs." Similarly although most of the areas are given in acres, hectares are sometimes employed. In some cases the kind of unit used in the tables is not sufficiently clear, as, for example, in the section on Brazil, pp. 124-127, where some columns are headed "tons" and others have no heading at all and one must refer to the text to find that they are all metric tons. Elsewhere the figures are given as "tons" without qualification when they are really metric tons. Again, on p. 137, the production of sugar in the Union of South Africa is given in "long tons"; there is a table just above giving the "price per ton" of sugar and cane, but on referring to the preceding paragraph we find that it is the price per short ton (2,000 lb.). Instances such as this detract greatly from what would otherwise have been a most valuable work of reference to all those interested in the sugar trade.

KAKAO. Wandlungen in der Erzeugung und der Verwendung des Kakaos nach dem Weltkrieg. By Dr. Fritz Klopstock. Wandlungen in der Weltwirtschaft, Heft 12. Pp. viii + 138, 9 × 6¼. (Leipzig: Bibliographisches Institut Aktiengesellschaft, 1937.) Price RM. 6 : 50.

This book deals with the changes in the production and uses of cocoa since the Great War and is divided into four parts. In the first part the author deals with the cultivation of cocoa and its problems, and separate sections are devoted to plantation cultivation and to native cultivation in West Africa. The special problems connected with native cultivation form a separate section in this part, in which the problems are discussed in detail.

The second part is devoted to the trade in raw cocoa, full consideration being given to the part played by the Terminal markets in the cocoa industry.

Changes in raw cocoa consumption are reviewed in the third part and separate sections are devoted to the cocoa industry in the five most important consuming countries, Switzerland, Holland, Germany, Great Britain and the United States of America, in which the author deals with the development of the industry in each of the countries mentioned. Much useful information is given in these sections regarding the trade trends in the respective countries.

The last section deals with the price of raw cocoa before and after the Great War, the problems of market regulation and the schemes which have been proposed with a view to maintaining the price at a remunerative level for the producer.

A useful bibliography is included and statistics of world production, consumption and stocks for recent years are given in an appendix.

UTILISATION OF FATS. By H. K. Dean, B.Sc., Ph.D., A.I.C. Pp. xiv + 292, 9½ × 6. (London: A. Harvey; New York: Chemical Publishing Co. of New York, Inc.; Toronto: Westman Publications, Ltd., 1938.) Price 15*s.*

During the last ten years or so a considerable amount of research work has been carried out on the composition of oils and fats and of the structure of the various glycerides contained therein. The results thus obtained have made possible a closer correlation of the structure of oils and fats with their utilisation. This relation is emphasised by the author in this book, in which the technical applications of these materials are deduced from the structure of their component glycerides rather than from their general characteristics. Chapters are devoted to a description of the various uses to which oils and fats are put. Among the branches of industry dealt with are those concerned with edible oils, with paint and varnish oils and with soap-making oils. In connection with these uses sections are included on the biochemistry and rancidity of oils, the theory of drying and polymerisation and the physical chemistry of soaps and saponification. Information relating to the utilisation of oils and fats is supplemented by ancillary chapters on their constitution and properties, their composition and classification, the classification being according to their major components, characteristic acids and botanical or zoological families. Further sections give methods of analysis and of determining composition. In addition the preparation of artificial fats by synthesis and hydrogenation is described. The contents are completed by a chapter on extraction and refining.

VEGETABLE DYES. Being a Book of Recipes and other Information for the Dyer. By Ethel M. Mairet. Pp. 68, 8¾ × 5½. (London: Messrs. Faber & Faber, Ltd., 1938.) Price 5*s.* net.

In spite of the high standard to which synthetic dyes have attained and their almost universal adoption in industry, it is nevertheless desirable that we should not allow the practice of dyeing with natural pigments to become a lost art. Detailed information on the actual methods of using vegetable dyes is not always easy to obtain, as the literature on the subject is scattered and the accounts are often only of general interest. In Mrs. Mairet's book, however, this information is collected together and set out in concise form for anybody to use.

Notes are given on the common fibres, silk, cotton, wool and linen in relation to the dyeing process, the two first-named receiving special attention. The nature and use of mordants is described. The treatment of the dyes themselves includes a list of British dye plants, a chapter on the lichen dyes and detailed recipes for dyeing different shades of blue, red, yellow, brown, black and green, using a variety of natural dyestuffs.

There is also a glossary, a short bibliography of considerable historical interest and an index. This useful little book was first published in 1916 and the fact that this impression is the sixth indicates that it is meeting with a well-earned demand.

FOREST PATHOLOGY. By John Shaw Boyce, M.A., M.F., Ph.D. Pp. x + 600, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1938.) Price 30*s*.

This volume, giving an account of the symptoms, causes and control of diseases of forest trees, is intended to serve both as a textbook for forestry students and as a reference work. Its value in the latter capacity is assured by the numerous references to the literature which are included with each chapter and their close correlation with the text, making the book a useful starting-point for more detailed study.

The first three chapters are by way of introduction, giving some account of the nature of plant diseases and a brief review of the fungi and their classification. There follows a chapter on physiological diseases and in the remainder of the book the diseases are grouped together for description according to the part of the tree attacked. A comprehensive survey of the pathology of forest trees is thus given, from seedling diseases to the decay and deterioration of dead wood and timber products, including both lumber and wood pulp; there are also discussions of certain special aspects, such as mycorrhiza and root-nodules. To complete the text there is an interesting chapter on the principles of forest-disease control. Mention must also be made of the numerous excellent illustrations in the text and of the two appendices, the one on fungicides and the other giving the botanical equivalents of common names of trees.

PLANT ECOLOGY. By John E. Weaver and Frederic E. Clements. Second Edition. Pp. xxii + 601, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1938.) Price 30*s*.

During the nine years since its appearance in the first edition, Weaver and Clements' *Plant Ecology* has gained the reputation of a standard text-book well known to botanists all over the world. Over this same period there have been great advances made in our knowledge and understanding of many branches of ecology, and the publication of a second edition of this work is therefore welcome as giving a presentation of the subject in accordance with modern ideas and progress. The text has been thoroughly revised and is enlarged to the extent of 80 pages, with a number of changes in the order of presentation.

Although perhaps of primary interest to botanists, the book can be studied with profit by agriculturists and those concerned with the conservation of wild life, for in both these fields a knowledge of the environment is of first importance. For example, as the authors point out in their preface, " the heavy toll exacted by erosion on tilled lands must be overcome in the main by farming systems that are in harmony with the environment—the normal climatic and vegetational processes."

ANNUAIRE INTERNATIONAL DES MINERAIS ET MÉTAUX. Édition 1938-39. By Robert Pitaval and Raymond Sevin. Pp. 342, 8½ × 5¼. (Paris: Société des Publications Minières et Métallurgiques, 1938.) Price: France, 55 frs., Foreign, 60 frs.

This work is mainly a directory of the more important mineral producers, consumers, agents, brokers and merchants of the world. The latest edition of this useful work is very similar to that of 1935 (noticed in this BULLETIN, 1935, **33**, 529), but smaller.

It is roughly divided into three sections. The first section of 51 pages summarises the general world position with respect to metals and minerals, and includes notes on the London Metal Exchange, the Hamburg Metal Bourse and the main exchanges of France.

The second and major section is larger by 61 pages than the corresponding section in the 1935 edition. About 50 minerals and metals are surveyed from an international point of view and in most cases the names and addresses of the more important producers, agents, consumers, etc., are given. Lists of appropriate mines departments, colleges, learned societies, publications, etc., in France and its colonies and of analytical laboratories in France, Belgium and England are also included.

The last section, consisting of four pages only, gives a very short list of the main European mineral and metal merchants, agents and brokers.

The publishers have reverted to their former practice of binding in a paper cover, without thumb-index, in spite of the increased price. The subject matter, although by no means exhaustive, has been revised and brought up to date, and the usefulness of this reference book remains unimpaired.

QUARTZ FAMILY MINERALS. By H. C. Dake, Frank L. Fleener and Ben Hur Wilson. Pp. xvi + 304, 8 × 5½. (London: McGraw-Hill Publishing Co., Ltd., 1938.) Price 12*s*. 6*d*.

Whilst purporting only to be a handbook for the mineral collector, this work succeeds in touching upon a number of topics of more serious geological significance than the mere description of the many varied and charming forms of quartz prized by the mineralogical tyro and is well calculated to arouse a deeper interest in the subject than haphazard collection.

The book opens with a short account of the value of knowing something of mineralogy, followed by a historical account of quartz from the Stone Age onwards, and in the third chapter, oddly named " The Way to Quartz," one encounters the first serious academic considerations. Tracing the formation of matter briefly from primordial cosmic conditions, the authors touch on atomic structure, valency (about which in error the humorous statement is made on p. 27, " Elements also possess different valances ") and the physical characteristics of oxygen and silicon. This chapter also deals with the relative predominance of quartz in the earth's crust, its physical properties, use as a geological thermometer, optical properties, and coloration. Throughout this part of the book as well as the following chapter on " The matter of crystallisation " the authors display a propensity to introduce advanced conceptions with but very inadequate explanations, presupposing a degree of knowledge not possessed by the average mineral collector. Such a procedure does not add to the clarity of the text.

After a short chapter devoted to the elementary crystallography of quartz, attention is turned to the various forms of quartz encountered in nature, and here one may disagree with the sub-division adopted, viz., into crystalline forms, massive forms, intermediary forms, cryptocrystalline and amorphous forms, agate-chalcedony, geodes and " thunder eggs," unusual quartz types, and the opal. These eight chapters might very well have been grouped broadly into crystalline and amorphous types with perhaps a third section on quartz as a rock-forming mineral. By some such method undue repetition and confusion would have been avoided, and it is difficult to agree with the authors' claim that their arrangement enables the story of quartz to "move along more smoothly" (p. 104).

The book concludes with two interesting chapters devoted to extensive areas of silification such as petrified forests, and the art of cutting gem quartz, in which cabochon cutting, specimen finishing and facet cutting are described.

There are excellent illustrations throughout the work and a short bibliography of books and articles and a subject index are also included.

THE ECONOMICS OF THE SULFURIC ACID INDUSTRY. By Theodore J. Kreps. Pp. xiii + 284, 8¾ × 6. (California: Stanford University Press; London: Humphrey Milford, Oxford University Press, 1938.) Price 23*s*.

The author of this book has studied economic problems connected with chemical technology over a period of more than ten years. During that time he has visited chemical plants in the United States and has travelled in England and Germany collecting information. He is thus well qualified to present an economic survey of the sulphuric acid industry. The book is mainly concerned with the United States, whose production of sulphuric acid now exceeds that of any other country, but the conclusions drawn are of general interest.

The bulk of the sulphuric acid produced in the United States is consumed internally in various industries, a negligible amount being exported. The description of the rise of the sulphuric acid industry and the subsidiary processes in which the acid is used affords a reasonably complete summary of the chemical industry of the United States, which is dominated by huge combines each making a large number of products.

The author is concerned with technical details only where they may be used to illustrate a particular point of economic importance, although in many cases it is difficult to differentiate between technical and economic considerations. The sections dealing with the relative successes of the contact and chamber processes in relation to the demand for acids of various strengths and with the types of raw materials employed in different manufacturing districts, illustrate the many problems which chemical industry has to solve, apart from the actual operation of a process.

Various labour problems, such as the type of worker required, working conditions, health hazards and the prevention of accidents are broadly considered and the book ends with a survey of the many uses of sulphuric acid and a forecast of its future importance. The author points out that a number of recent industrial developments have resulted in a reduction of the demand for sulphuric acid, an important example from the point of view of the United States, where the superphosphate industry is a large consumer of sulphuric acid, being the blast-furnace process for producing phosphatic fertilisers from phosphate rock without the aid of sulphuric acid.

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PLANT GROWTH-SUBSTANCES. By Hugh Nicol. Pp. xii + 108, 8½ × 5½. (London: Leonard Hill, Ltd., 1938.) Price 3*s.* 6*d.*

HUMUS. ORIGIN, CHEMICAL COMPOSITION, AND IMPORTANCE IN NATURE. By Selman A. Waksman. Second Edition, Revised. Pp. xiv + 526, 9 × 6. (London: Baillière, Tindall & Cox, 1938.) Price 30*s.*

TECHNOLOGIE DU CAFÉ. Les Caféiers de la Côte d'Ivoire. Deuxième Partie., By Edmond Sibert. Pp. 112, 9¾ × 6½. (Paris: Centre d'Études Coloniales, 1938.) Price 30 francs.

THE PRINCIPLES OF CANE SUGAR MANUFACTURE. By J. G. Davies. Pp. viii + 144, 9½ × 6. (London: Norman Rodger, 1938.) Price 10*s.*

INSECTS OF CITRUS AND OTHER SUBTROPICAL FRUITS. By Henry J. Quayle. Pp. ix + 583, 9 × 6. (Ithaca, New York: Comstock Publishing Company, Inc., 1938.) Price $5.00.

COTTON. History, Species, Varieties, Morphology, Breeding, Culture, Diseases, Marketing, and Uses. By Harry Bates Brown, A.M., Ph.D. Second Edition. Pp. xiii + 592, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1938.) Price 30*s*.

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